SEVENTY-SIXTH YEAR

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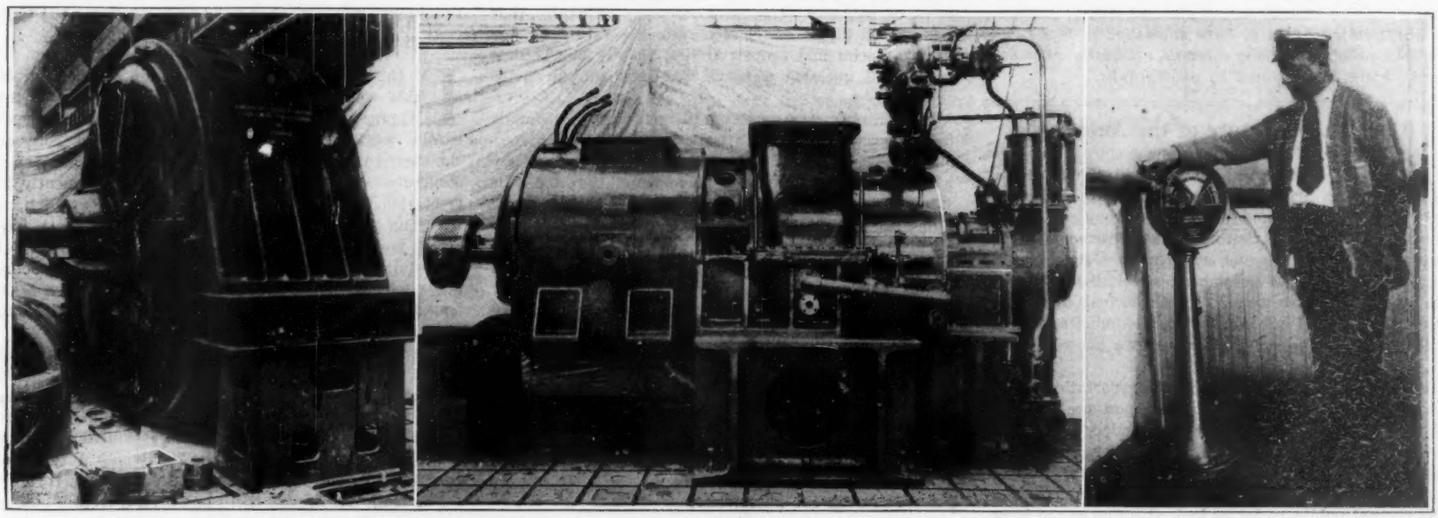


Left: The induction motor which, at 100 revolutions per minute, develops 3,000 horse-power for driving the single screw. *Center:* The steam turbine and generator unit which supplies alternating current to the single induction motor. *Right:* Chief Officer of the "Eclipse" at the safety steering device on the bridge. One man can control the movements of an electrically-driven vessel almost as easily as a motorman can drive a street car

Some features of the electric drive used aboard the S. S. "Eclipse," one of eleven Shipping Board freighters to be so equipped

Electric Propulsion for Our Merchant Marine

EVIDENTLY, electric propulsion of ships has reached that stage in the development of a new art at which general recognition of its value is shown by rapidly extending use. The latest proof of this is shown in the fact that within a few weeks, the United States Shipping Board steamship "Eclipse," which is being fitted with electrical propulsion, will be placed in service. This is one of eleven other freighters of the Shipping Board's fleet which are also being equipped with the electric drive.

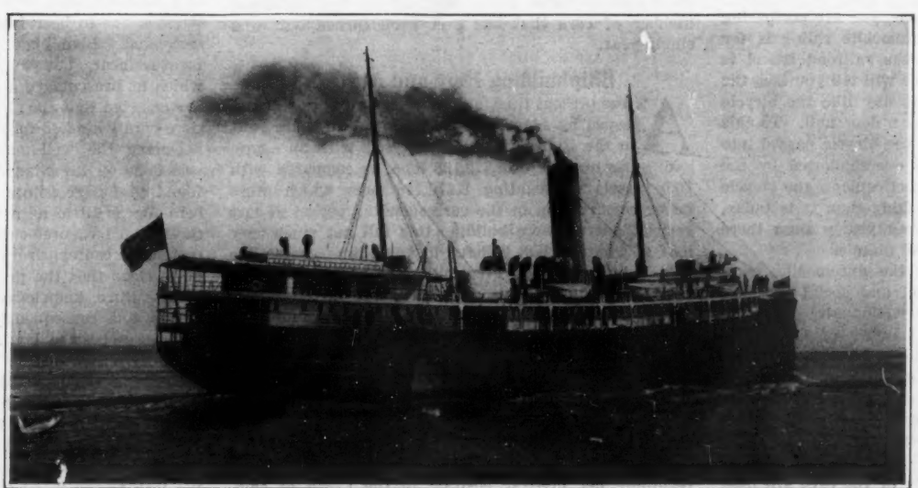
"Eclipse" is a vessel of 11,868 tons. The electric propulsion plant which is being constructed by the General Electric Company has been installed and the vessel will soon be placed in service. The plant consists of a steam turbine generator, directly connected to an alternating current generator, the current from which is fed to an induction motor on the propeller shaft, which at 100 revolutions per minute develops a shaft horse-power of 3,000. One of the great advantages of the electric reduction gear is that the speed of the ship and its general maneuvering, so far as the motive power is concerned, can be controlled from the bridge by means of the safety steering device which is shown in one of our illustrations. The bulk of the Shipping Board fleet is equipped with the mechanical reduction gear, and when a considerable number of these electric installations are in service, it will be possible to make some interesting comparisons of the two methods and gather additional valuable data as to their respective efficiency.

Driving a ship by electricity means revolving the propeller shaft from a motor just as trolley cars are driven by motors on the car tracks. To supply "juice" to turn this motor, a generator must be operated somewhere else in the boat, just as generators in power houses make current for street railways. On shipboard these generators may be driven either by an economical steam turbine or by a Diesel engine.

The records of the battleship "New Mexico," the U. S. Navy's first electric ship, show that oil consumption is lowered about one-third by the electric drive, while a greater and more flexible power is attained with far simpler mechanism requiring fewer operatives. It is even possible for the gigantic "New Mexico" to run at cruising speed with an engine room crew of one man, the electric mechanism requires so little attention. Of course, the great battleship will never operate so short-handed, except in emergency, but it can be done.

The idea of driving a huge merchant ship through the seven seas almost with the ease a motorman drives a street-car through city streets may seem humorous, but there is no humor in the basic scheme. It is not only possible for an officer to run his boat with small levers on the bridge, but this is being done. The economies of utilization of hull space, and of fuel are such that students of shipping are beginning to realize what the electric drive means for the rising merchant marine of this country.

Strange to say, however, the first application of the electric drive principle was made on a type of vessel closely resembling the merchant ship, although in reality it was a naval collier—the U. S. S. "Jupiter," launched in 1912. The immediate success of this installation was what paved the way to the adoption of the electric drive in the navy where all of the capital ships of the future will be thus propelled.



The "Cuba"—first electric-drive passenger ship. The sister ship to the "Cuba" is the "Florida"

Synthetic Benzine

THE remarkably interesting and important announcement was made in *Flugwelt* that certain German scientists have succeeded in producing synthetic benzine. It has been found that in the presence of the coal tar of lignite and when heated under a high degree of pressure, hydrogen combines with the hydrocarbides contained in coal tar.

This discovery was made in the laboratories of the Badische Anilin u. Soda Fabrik. The general statement is made that it has been found possible to produce hydrocarbides analogous to those found in petroleum by means of high pressure, taking carbon monoxide and hydrogen in the presence of suitable catalyzers.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Assured Future of the Automobile

A THOUGHTFUL survey of our modern civilization, as expressed in the broad field of engineering, teaches us that there are certain industries, which because of the enormous benefit they confer upon mankind, become so thoroughly interwoven with the fabric of human life and activity, that they may be considered to be as permanent as civilization itself. In proof of this statement, it is sufficient to mention the railroad and the steamship. Eliminate both or either of these, and civilization, as we know it today, would cease to exist.

And what steam has done for transportation during one hundred years of development upon sea and land, the internal combustion motor has equaled, and in some respects excelled, in a brief twenty years of development upon the hitherto neglected highways of the country. This astonishing fact is little understood by the general public, so let us look at a few of the incontrovertible facts.

There are today in the United States some 7,000,000 motor vehicles. If we assume a conservative yearly mileage of 3,000 miles per car, the total mileage must be 22,000,000,000 miles per year; and if we assume an average of three persons per car, we arrive at a total passenger mileage of 66,000,000,000 miles. Compare this with the figures for 1919 as given out by the Association of Railway Executives, which claim a yearly passenger mileage of some 46,000,000,000 miles. So that this lusty young giant in the field of transportation has a total passenger mileage to its credit nearly 50 per cent in excess of that on our entire railroad system, with its 260,000 miles of track.

Again, in 1919, automobiles, on a basis of 300 days in use and an average of only two persons per car, carried 4,535,000,000 passengers. Compare this with the latest Interstate Commerce Commission figures which show that the railroads carried in 1918 1,124,000,000 passengers, or one-fourth of the number carried in automobiles.

But, says some doubting Thomas, you are comparing two vastly different things; automobile riding is for pleasure—mere junketing, whereas railroad travel is serious—a business necessity. He will tell you that the automobile "craze" will have its day like the bicycle craze, which is as dead today as a door nail. To this it is sufficient to say, first, that the bicycle passed into seeming eclipse because it was overshadowed by the automobile and second, that statistics show the bicycle industry was never more flourishing than it is today, more bicycles being manufactured yearly than there were in the palmiest days of the nineties.

But the real significance of the automobile, as a leading utility in our industrial and social life, has recently been determined by a questionnaire conducted by the National Automobile Chamber of Commerce, which was sent to automobile license holders, selected at random from the registration lists of ten widely separated States. The answers received in reply to the first 10,000 cards of this survey are very illuminating, since the results may be considered to be highly authoritative and reliable.

We find that 10 per cent only of the cars are used exclusively for pleasure and that 90 per cent of them are used more or less for business; that 60 per cent of the average car mileage and no less than 78 per cent of the farmer car mileage is to be credited to business; that 34 per cent of the average mileage represents the substitution of the automobile for the trolley or the railroad and the use of the car where there is no other means of communication; and lastly and most important of all it is found that the average car owner, according to his own testimony, adds 57 per cent to his output through use of the automobile, and that the farmer adds 68 per cent to his efficiency.

Now consider the fact that more than 2,300,000 families have been enabled to live in the suburbs or otherwise improve their home surroundings, and that a working force equivalent to 1,600,000 laborers is being applied to farming, and we think it will be agreed that so far from the automobile being a mere instrument of pleasure, it is an instrument of utility that has woven itself so closely into the fabric of our modern social and industrial life, that it has become beyond all question a permanent part of our civilization.

Furthermore, we must not forget that in bringing these material benefits to the individual, the automobile has been responsible for the creation of an industry whose growth has been so phenomenal that today it stands as easily the second largest in the country. Thus, the capital invested in the automobile industry for 1919 exclusive of parts and accessories makers was $1,015,443,338, and in the same year the total motor vehicle production was 1,974,016. The value of this product was $1,885,112,546, which is equal to the value of the total annual production of anthracite and bituminous coal in this country. The industry employed 300,000 men in the production of motor cars and motor trucks, and its annual payroll was $374,933,856. With such figures in mind, no one will be disposed to question the statement of a well-known authority that "the greatest single new productive force in the development of the United States in the past twenty years has been the automobile."

Today the automobile industry, in common with all others, is passing through a period of readjustment, and there are many indications in the case of this particular industry that the readjustment is nearing completion and that early in the coming year everything will be in full swing upon a new and more solid basis. Of this we may all be assured, that there is not now nor has there been at any time any question of the permanent prosperity and the continued future growth of the industry. It is estimated that if the car market were confined merely to replacements, over 1,000,000 new automobiles would be needed every year. There are, as we have said, some seven million cars in the United States. There are in all Europe only about one million cars. It is the belief of automobile men that not until the rest of the world has as many cars as the United States will the industry in this country experience anything more than a temporary abatement in the demand. Should the day come when Europe, like America, has seven million cars, there will be a demand, merely for replacements, which will be from two to three times as great as the maximum number of cars that has ever been turned out in a single year.

Shipbuilding Here and Abroad

AT the present time, according to statistics recently issued by *Lloyd's Register*, there are being built in the United States 312 vessels with an aggregate gross tonnage of 1,772,193 tons, as compared with 767 vessels aggregating 3,470,748 tons which were under construction in the corresponding period of last year. That we were building this fall not much over half of what we had in hand last fall is of course due to the fact that the great program of the Shipping Board is being rapidly completed, and no additional vessels are being laid down by the Board. An interesting fact is the large number of tankers which are now under construction. The United States is building 79 of these, of 545,302 total tonnage, and the United Kingdom is building 32, with a total tonnage of 232,758. Three other tank steamers are being built in other foreign countries.

Lloyd's statistics show that the United Kingdom is regaining her pre-war position in the world of shipbuilding. At the end of September this year, 961 ships were being built in British yards, and their total gross tonnage was 3,731,098 tons, an increase of 914,000 tons over the amount that was building a year ago. This represents an increase of 32 per cent for the year, and of over 90 per cent as compared with the figures for September 1913. Note should be taken of the fact that a large proportion of these ships are of considerable individual tonnage. Thus, there are now building in British yards 64 vessels of 10,000 tons or over, 57 vessels of 12,000 tons or over, 25 of 15,000 tons, and 4 vessels of between 24,000 and 25,000 tons.

Next to the United States comes Holland, which has in hand 165 ships of 423,400 tons. Italy is building 156 vessels of 365,313 tons, and France, 89 ships of a total tonnage of 292,608. Japan, with 72 vessels of 262,407 tons on hand, is building less than she was a year ago. Shipbuilding has declined, also, in the British Dominions, which have in hand 89 ships of 213,894 tons.

Saving Steel in Bridge Design

IN the early, very early, days of engineering in this country, it was customary to speak of the "factor of safety" in a structure. The factor of safety was supposed to express the ratio between the maximum load which was supposed to come upon a structure and the breaking load. Not infrequently in steel structures, this factor of safety was as high as five; and thirty or forty years ago the same rough-and-ready method resulted in that magnificent structural material, the Douglas fir of the Pacific coast, being subjected in bridge work to a stress of only 1,000 pounds per square inch when its breaking strength was not less than 10,000.

A growing recognition of the unscientific character of the factor-of-safety method, coupled with a demand for reasonable economy, led to the substitution of the unit-stress method, in which the maximum stress to which the steel shall be subjected is stated, the unit stress varying according to the particular duty to be performed by the various members of the structure.

For many years past there has been a feeling among engineers that the unit stresses were too low for the highly reliable steel which is now available, and we note that a committee of the American Railway Engineering Association has proposed that the carrying capacity of existing bridges be rated on the basis of unit stresses, ranging up to the high figure of 26,000 pounds per square inch.

Now any competent modern bridge engineer will admit that 26,000 pounds per square inch is a perfectly reasonable figure, provided that the preparation of the strain sheet and the design of the details of the bridge are in thoroughly competent hands, and the inspection of the steel both at the mills and in the fabricating shops is conscientiously carried out by qualified men. A great reduction in the present margin between the working stresses and the breaking stresses can be safely met only if the above conditions are most rigorously fulfilled.

In some very interesting comments on this subject, *Engineering News-Record* lays emphasis upon the fact that the secondary stresses created during the erection of a bridge should receive very close attention if unit stresses are to be raised to the point which has been suggested. Live load stresses are all susceptible of measurement, but to determine secondary stresses, which at present are a matter of much uncertainty, it is suggested that they should be measured by means of gage points applied to the structure before its erection.

During the well-known reinforcement work which was done on the Niagara Railway arch bridge, it was found that gage points can be placed on bridge members for as little as a dollar or two per pair. Since the initial measurements would not add heavily to the cost, our contemporary considers that it should be quite clear that the preparatory work for giving complete future knowledge of dead load stresses in a bridge, and consequently of the total stresses, can be done at a cost so low as to be completely negligible. The alternative to this is to meet the secondary stress problem in a haphazard way by adding more metal to take care of it. It is to be hoped that this very practical suggestion will be followed out. Every reasonable proposal to prevent the use of unnecessary steel in bridges should commend itself to the civil engineer. We look to see this admirable suggestion incorporated in bridge practise.

Electricity

The Unusual in Searchlights.—In a recent issue of *Elektrotechnische Zeitschrift* there appears a description of a decidedly novel searchlight installation aboard German warships. Two plane mirrors are used to throw out the beam of light, the searchlight itself being placed inside the hull of the ship and in a protected position, while the beam of light is passed up through the hollow steel mast of the ship and projected by a mirror at the top.

A Snap-Switch Handle That Cannot Be Unscrewed has been introduced by a leading manufacturer of electric appliances. This is accomplished by means of a ratchet built in it. The handle may be substituted for the ordinary handle. The ratchet escapement comes into play when the handle is turned in the reverse direction so that it cannot be loosened or removed. By using a small screw-driver on a screw which is well recessed in the center of the handle, the ratchet is released. These handles may be used to prevent the removal of "dead-front" insulated covers of safety panel switches.

A New Canadian Niagara Power Project is described in a recent issue of *The Electrician* of London. The new water-power development, which is now under way, purposes to utilize nearly the full drop between Lake Erie and Lake Ontario and require for maximum capacity practically all the flow now permitted Canada under the international agreement. It is known as the Queenston-Chippawa hydraulic development. The present scheme contemplates the development of 500,000 horse-power and 305-foot head, using ten 50,000-horse-power turbines, five of which have been ordered. A description of this work will appear in an early issue of the SCIENTIFIC AMERICAN.

Why Clark Standard Cells Fail.—The causes and effects of the cracking of Clark cells at the amalgam terminal and the formation of gas in the amalgam limb are discussed in Scientific Paper No. 390, "The Two Common Failures of the Clark Standard Cell," issued by the Bureau of Standards, Washington, D. C. The methods employed in an attempt to eliminate these defects are also given. It is shown that the cracking of the cell can best be prevented by a very simple expedient of using a cell blank in which platinum wire previously subjected to the action of zinc amalgam is employed as the negative terminal, and also that the effects of gas formation can be minimized through the employment of the smallest excess crystals required to insure saturation at the highest temperature at which the cell is to be used.

Aluminum for Telegraph and Telephone Lines is a subject that has received some attention in Germany, where the scarcity of copper has caused the telegraph administration to investigate the possibility of using aluminum for signaling plants. Difficulties were experienced in finding methods for making reliable joints in cables, resistances of several ohms being often observed on carefully made twisted joints. For bus bars, however, aluminum appears to be just as good as copper. Telephone condensers up to 2 mf. in capacity were made with aluminum foil and paper, with the same exterior dimensions as the ordinary tinfoil and paper condenser, continues *Elektrotechnische Zeitschrift*. On alternating-current tests the aluminum foil condensers were found to have much smaller losses than tinfoil condensers, the power factor of the new condensers being only one-fifth to one-eighth that of the ordinary type.

Direct or Alternating Current?—There is a decided tendency among certain groups of European engineers to put all direct-current electrification under a common classification as the "American system," and, accordingly, to assume that direct current is the only form of supply accepted in America for railroad electrification. This tendency is vigorously opposed by an author in *Elektrotechnik und Maschinenbau*. This German author maintains that little stress should be laid on the fact that direct-current supply was chosen for the Chicago, Milwaukee and St. Paul electrification, in view of the peculiar circumstances which affected the choice. First of all, he says, the already existing three-phase transmission lines lifted the burden of transmission-line construction from the backs of the electrification engineers, enabling them to get access to power at any point on the road, so that numerous converter stations could be easily erected all along its length. The author further declares that Swiss and German progress in single-phase traction is very little appreciated in America and that one important reason for choosing direct current for the road mentioned was the lack of time for investigation and trial in a period when any kind of electrification was sure to promote economy.

Science

League of Belgian Scientific Societies.—Thirty-three scientific societies in Belgium have formed the Fédération Belge des Sociétés des Sciences Mathématiques, Physiques, Naturelles, Médicales et Appliquées, with headquarters in Brussels. The federation will aid the several societies in keeping up their publications, provide facilities for international exchange of publications, summon congresses, hold expositions, etc. The president for 1920 is Prof. de la Vallee-Poussin, of Louvain.

"Physiological Reviews," published quarterly in Baltimore, beginning January, 1921, by the American Physiological Society, is the latest addition to the list of scientific journals designed to present periodical reviews of progress in particular fields of knowledge. Instead of abstracting individual papers separately, this journal will summarize and compare results, and a bibliographical list will accompany each article. It will therefore be a publication similar in purpose to *Ergebnisse der Physiologie*, the Harvey Lectures, and others of the same sort.

The Writings of a South American Paleontologist.—A complete edition of the scientific writings and correspondence of the South American paleontologist Florentino Ameghino, who died in 1911, is now in course of publication at the expense of the government of the Province of Buenos Aires, Argentina, and under the editorship of Alfredo J. Torcelli. The edition will run to a very large number of volumes, as Ameghino was the author of 179 essays and books, few of which are short while some are large volumes. They are at present difficult of access to most scholars.

Submarine Photography from Airplanes.—Writing in the *Geographical Review* on the subject of aerial photography as an aid to geography, Mr. Willis T. Lee, of the U. S. Geological Survey, deals at length with the application of this process to photographing and mapping submarine features. The visibility of objects at great depths in clear water from a point far above the surface has been a well-known phenomenon since the wartime period of "sub" chasing by airplane. It is said that objects 45 feet under water have been successfully photographed, and that with the proper plates and ray filters the presence of submerged objects invisible to the eye is revealed by the camera. It has been found possible to use this method of observation to some extent in detecting and mapping sand bars, shoals, drowned terraces and channels. Mr. Lee presents several photographs illustrating the results of the method. Not all photographs of coast lines reveal these subaqueous features. Certain conditions of the atmosphere and the water seem to be necessary for photographing them. "In studying the underwater features as shown in photographs," says the writer, "caution and careful checking in every possible way are necessary. Changes in hue in the photograph might be due to sediment in suspension rather than to differences in depth of water."

Aridity as an Asset in Agriculture.—The idea that an arid climate is a blessing to the farmer will strike most people as novel and paradoxical, but a good case in favor of this idea can be made out. In a valuable report on the Columbia Basin Irrigation Project, published by the State of Washington, the following facts are set forth regarding the influence of aridity on agriculture: The almost continual sunshine accelerates plant growth. The soil, constantly warm, prevents any cessation of root activity which would follow night chilling if cloudy weather prevailed in the daytime. An arid climate reduces harvesting costs and insures a higher quality of products, harvested without delay or spoilage by rain. The main point brought out, however, is that, with irrigation as a substitute for rainfall, water can be applied to the crops at the right time and only at the right time; also in just the right amounts. This fact is in accordance with current ideas in agricultural meteorology concerning the great importance of "critical periods" in the growth of any crop plant, when its exact requirements in respect to heat or moisture must be met in order to get the best results. The ideal plan would be to dispense with natural climate altogether and to grow all crops under controlled conditions of temperature, moisture, and probably other atmospheric factors. The above-mentioned report says: "The scant rainfall of the Columbia Basin area has been very beneficial for the future irrigationist. There has not been sufficient moisture to leach away the stored plant food, and at the same time adequate drainage has prevented the accumulation of alkali salts, which are the most soluble of the earth's constituents and are frequently found in poorly drained arid regions."

Automobile

England to Motorize Mails.—There are indications that the General Post Office of England is considering a great revival and extension of motor services for mails, particularly in the more remote country districts. As will be remembered, there was considerable progress in this direction during the years immediately preceding 1914. The war, however, necessitated considerable changes, resulting in a wholesale abandonment of road services and a reversion to "as you were" conditions. Efforts are now being made to recover the ground thus lost.

Peoria Taxes All Wheels.—The city council of Peoria, Illinois, has adopted a new wheel tax ordinance effective October 1. Even bicycles and tricycles, ridden by children, must pay a tax of $2 a year. The scale for horse-drawn vehicles ranges from $2.50 to $10; motor buses, $10; motor vehicles, not motor trucks, $4 to $8 a year; and motor trucks, $5 to $15, according to horsepower. Firms engaged in manufacturing or dealing in motor vehicles will be required to pay an annual tax fee of $6 for every dollar's license fee issued. There is much opposition to the measure, but the council holds that the conditions of the public finance forces the action. This action is unusual in that all vehicles are taxed. The usual procedure is to tax only motor vehicles and allow other users of the highways to use them without payment of any fee. It is hoped that other communities figuring on levying a wheel tax will include all vehicles and not make the motorists bear the entire burden as is the established custom.

Hauling Mill Work by Truck Profitable.—In the average wood-working plant there are two uses for the motor truck. One is to truck in lumber or raw material and the other is to truck out the finished product—that is, to make deliveries to the purchaser. The trucking-out proposition has more to it than many a wood-working plant has so far developed; it is practical and economical to make truck delivery over comparatively long distances if the road permits it. Investigation into truck service and cost bring to light the fact that in competition with short railway hauls, one can truck millwork and other items in manufactured wood at a greater saving than he can truck such heavy items as sand, gravel, cement and brick. The reason is that the heavy items take a very low freight rate, which motor trucking must compete with, while manufactured woodwork takes a comparatively high freight rate, consequently it can often be delivered by truck fifty or more miles more economically than shipping by railroad and there is a saving of one or two handlings.

Riveting Ring Gears.—Where the ring gear is attached to the differential housing by rivets which have become loose, the first step is the removal of the old gear by chipping off the rivet heads with a sharp chisel in order to drive the old rivets out or to drill out the rivet head if this is of the countersunk type. After the rivets have all been driven out and the old ring gear removed, the flange on the differential case should be carefully gone over and all upstanding burrs should be smoothed down with a file. Any irregularity on the flange will result in the ring gear being out of true, as far as its meshing with the driving pinion is concerned. Hot riveting is preferable to cold riveting because when the rivets are put in red hot they fill the holes better as they are headed over and additional holding power is secured by the cooling shrink. In order to make a neat job of riveting it is imperative to use a rivet set. A skilful mechanic may be able to form up a head with a peening hammer but this at best is a slow job and there is always some danger of injuring the differential casing or the gear teeth should the hammer slip.

Tightening Bearing Cap Bolts.—A point to observe is to make sure that the heads of the bolts are imbedded solidly in their proper position and that they are not raised by any burrs or particles of dirt under the head which will flatten out after the engine has been run for a time and allow the bolts to slack off. Similarly, care should be taken that there is no foreign matter under the brasses and the box in which they seat. To guard against this the bolts should be struck with a hammer several times after they are tightened up, and the connecting rod can be hit sharply several times under the cap with a wooden mallet or lead hammer. It is important to pin the brasses in place to prevent movement, as lubrication may be interfered with if the bushing turns round and breaks the correct register between the oil hole in the cap and brasses. Care should be taken in screwing on the retaining nuts to insure that they will remain in place and not slack off. Spring washers should not be used on either connecting rod ends or main bearing bolts, because these sometimes snap in two pieces and leave the nut slack. The best method of locking is to use well-fitting split pins and castellated nuts.

Power and the City

Some Facts and Figures on How Los Angeles Has Harnessed the Distant Mountain Streams

By Crittenden Marriott

A FEW years ago, when Los Angeles completed its 235-mile aqueduct to bring water from the mountains, a great deal was published concerning the magnitude of the work and the benefits that would follow its creation. It is safe to say, however, that few people noted and that fewer still have remembered that one of the great objects to gain which the people of Los Angeles spent $24,500,000 was the development of hydroelectric power.

Nearly everyone in the East thinks of an aqueduct merely as a means of obtaining water for drinking and other domestic uses—and in the West, perhaps as an adjunct in near-city irrigation. But when these primary needs have been met that of power remains. A great industrial city depends on cheap power as much as it does on drinking water. Coal is lacking in the West; and though fuel oil is at present abundant it will not last forever. But water power will.

The builders of the aqueduct realized this, and one of the objects of their work was to develop water power and to transmit it electrically to the city in order to build up there a vast industrial system. Today this object has become paramount; and the possibilities of the situation can no longer be blinked at. The bald facts are that Los Angeles today has 41,000 horsepower, municipally owned, in use and for sale; and before the close of the present year it will have 98,000 horse-power. And this is only about one-third of the power available from the aqueduct and its adjuncts, the other two-thirds waiting only on the installation of the necessary power-plant machinery to be available for use. This enormous potential power is due to the great fall between the intake of the aqueduct and the city and to the fact that the same water can be used over and over again, the total fall effective for power use being 1,900 feet. Its development has changed the destiny of Los Angeles, transforming a commercial city, dependent almost wholly on the agricultural and horticultural output of its "back country," into an industrial city whose possibilities are unlimited.

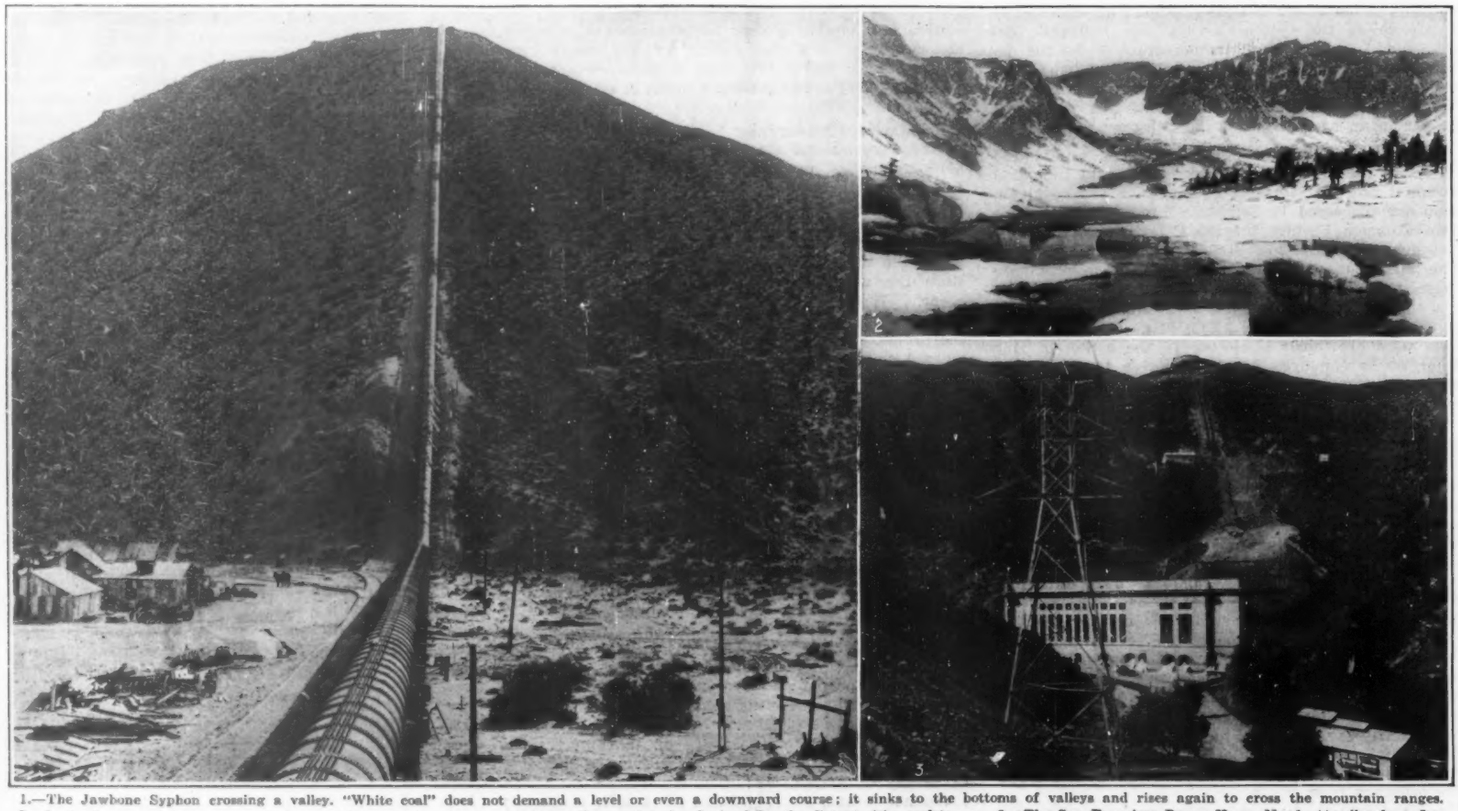
The reliability of the aqueduct power has just gone through a very severe natural test. For three years the Southwest, and the Pacific coast especially, has been going through a very unusual drought; and the rainfall for the winter of 1919-20, though far above that for the three winters preceding, was only just about normal. The State Railroad Commission, which in California has control of the water power of the State, has this year sent out an appeal to all power plants to utilize all existing power in the State to the utmost and not to let any available water run to waste. It has even been suggested that all the power plants in the State pool their resources for the common supply. Of all the plants the Los Angeles aqueduct alone was able to turn over a large amount of power to other companies for distribution and use outside the city.

So far as the water itself is concerned, the city, during the three years' drought, has greatly enlarged the suburban area to which it supplies water for irrigation; and it has just allotted for the use of the huge automobile tire factory (operating 33,000 spindles) which is about to begin operations, a supply of water double that used by the entire city of San Diego for all purposes. The total aqueduct discharge is 400 second-feet, equivalent to 258,000,000 gallons daily, which, in addition to supplies already developed locally, gives a total daily delivery of 325,000,000 gallons.

Of course the generation of hydroelectric power outside a city does not necessarily mean that the power is or can be reliably transmitted to the city workshops. However, all aqueduct power so far developed, and much of that not yet utilized, is or will be generated at plants that are very near the city and transmitted over lines whose capacity is far in excess of present loads. The lines to the city carry 100,000 volts; the city is encircled by duplicate 33,000-volt transmission lines (which extend to the harbor district at San Pedro, 16 miles away); and the industrial parts of the city are well provided with distribution power lines.

But what actual use has been made in a big way of the power that became available in some degree for the use of the city of Los Angeles three years ago?

Naturally the demand for domestic, office, street and home lighting had first to be met. After this came the steadily increasing demand of existing industries, large and small, including both those that changed their plants from oil-burning to electrical and those that bought the cheaper power offered by the city in place of that which they had theretofore bought from the two private power plants in the city. The difference in costs now and before the war makes it difficult to compare oil-fuel costs with electrical costs. However, a very careful estimate made by the local ice companies shows that their change to electricity has enabled them to save enough to cover the increase in wages of the last three years, the cost of treating the water, and the interest and depreciation on the new investment. In other words, electrical power at aqueduct rates has held the cost of ice making in Los Angeles to its pre-war standard; and the same is true of many other branches of industry.



1.—The Jawbone Syphon crossing a valley. "White coal" does not demand a level or even a downward course; it sinks to the bottoms of valleys and rises again to cross the mountain ranges. 2.—It is from such snow-covered slopes and mountain streams as these that water is obtained for the distant cities and towns. 3.—The San Francisco Power House No. 1, 44 miles from Los Angeles. The effective fall here is 938 feet, developing 69,000 horse-power. The high-voltage transmission line appears in the foreground, the penstocks in the background

Factors in the conversion of melting snow into electric power and light and heat for the distant cities and towns

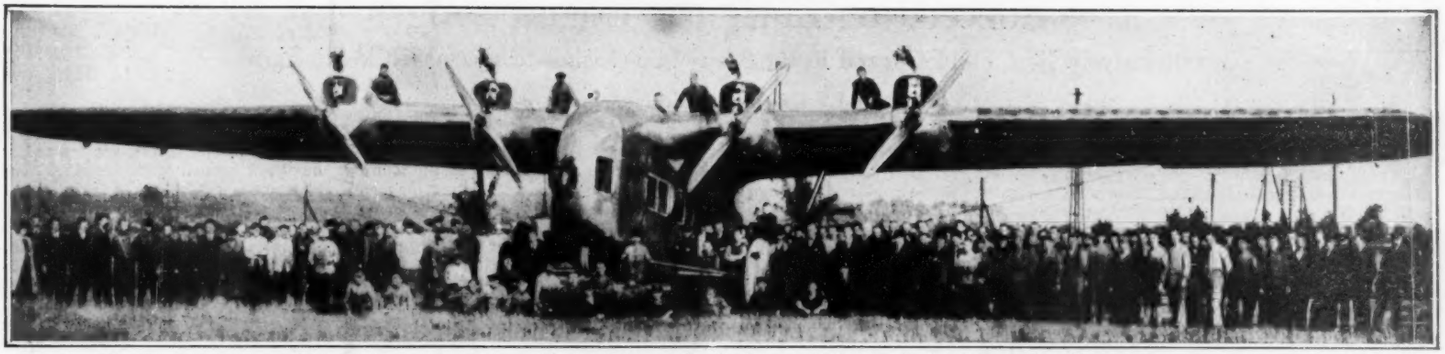
After existing needs were supplied, special attention could be given to supplying new plants built for the most part by industries that until then had been unknown in southern California.

As a rule men are pessimists when they are asked to transfer their business to, or to invest their money in, a region where no pioneer has marked the way for their particular line. At the very least they want time to consider. And it takes time to build factories, especially nowadays when both materials and labor are scarce and costly.

Nevertheless the vast advantages of cheap electric power of the aqueduct proved a powerful magnet. Since the power became available many small plants and some huge ones have been built and have gone into operation; others have nearly completed building and will start work during this summer or fall; and others have only just begun building.

The first great industry to succumb to the attraction of the magnet was that of ship building. The two big

(*Continued on page 620*)



The giant Staaken monoplane which carries a crew of two pilots and two mechanics in a cockpit atop the fuselage, and eighteen passengers in the comfortable cabin

The Unusual in Passenger-Carrying Airplanes

By Alfred Longville

SOME very radical changes are being introduced in aviation of late. Just as we had settled down in the comfortable belief that the passenger-carrying airplane, to be truly orthodox, had to have a number of engines each of which drove its own tractor or propeller screw, along came several new machines which cast aside our fond beliefs and start aviation off on a new course. He would be a brave prophet who would attempt to picture the winged passenger-carrier of the future, in view of the many new and promising ideas now being worked out.

The latest F.I.A.T. 12-seater biplane is a leader among the aeronautical revolutionists, so to speak. Instead of following the accepted practice of a multi-unit and multi-screw arrangement for the propulsion, the engineers of the Fiat organization have designed their huge machine with a triple-engined power plant mounted in the nose of the fuselage and driving a single tractor screw, as in the usual single-engined tractor machine of the 2- or 3-passenger class. In the new F.I.A.T. machine the engines are mounted side by side, each driving the single tractor screw through a gear box. Should any one of the three engines develop trouble, it is automatically thrown out of engagement; furthermore, simple arrangements are provided so that the pilot or mechanic may disengage any one of the three engines, thus enabling certain repairs or adjustments to be made while in flight. The combined horse-power of the three engines is 900 at 1,850 revolutions per minute; but the normal power developed during cruising flight is 700 horse-power at 1,600 revolutions per minute, giving a speed of 115 miles per hour instead of 125 miles per hour at full power. With two of the engines in operation 600 horse-power is obtained, which is ample to maintain cruising speed. From reports it appears that the Italian engineers have solved the problem of a suitable gear drive in a somewhat different fashion from certain French designs in which two or more engines are arranged in tandem to drive a single tractor screw.

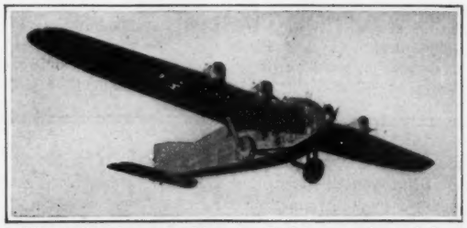
Another departure from standard airplane design is the great German monoplane which forms the cover illustration of this issue. This odd machine is the German "Staaken," built in one of the Zeppelin works where efforts of late have been concentrated on the airplane instead of dirigible type of airship.

The most striking feature of the giant "Staaken" is the arrangement of the engines. Following the lines of the all-metal construction of certain German machines, the "Staaken" has an exceptionally thick single wing which is so braced internally, between the top and bottom surfaces, as to require practically no external bracing. The engine units are mounted in the leading edge of the wing, two on either side of the fuselage, offering a minimum of head resistance. In all, the airplane has somewhat over 1,200 horse-power, and carries 18 passengers and a crew of 2 pilots and 2 mechanics. The nose of the machine is hinged and swings back so as to form a doorway into the cabin situated in the forward part of the fuselage. The pilots and mechanics sit in a cockpit on top of the fuselage and above the single plane, which position affords excellent visibility in almost all directions.

The giant "Staaken" is the outcome of a whole line of giant airplanes developed by Germany during the latter part of the war, and intended for long-distance bombardment of Allied cities and military depots. The all-metal construction is carried out in duralumin. The span of the single wing is 105 feet. The speed of the machine is given as 130 miles per hour, which is exceptionally fast for a machine of such large proportions and great carrying capacity.

Demolition Material as Fertilizer

AT the present time when fertilizer is so much in demand, various materials which could be used for this purpose should not be overlooked. From a French source we find it recommended to use lime and plaster material coming from demolitions, and it contains very useful fertilizing ingredients. Such material can find a very good use on land which is poor in lime and which is situated in the region around good-sized towns. The cost is scarcely anything, and the haulage to the spot would be practically the only



Giant Staaken machine in flight, carrying eighteen passengers with all the comforts of a railroad coach

expense. Material from demolition consists of dry mortar with some fragments of stone, that is, as regards the waste products which cannot be used again. The composition of mortar will be seen by observing how it is made up in the first place, mortar being formed in fact of sand and lime in varying proportions according to use. In general the makeup contains 30 to 40 per cent of lime which afterwards becomes partly transformed to carbonate of lime or chlorohydrate and nitrate. Nitrification is found to be most active in the walls of the ground floor, and there is also formed in many cases nitrate of potash. It will thus be observed

Nose of the Staaken machine, showing the hinged front which swings back so as to give access to the passenger cabin

that this material is rich in nitrates, and it can therefore be employed to advantage as a calcareous fertilizer and as a source of valuable nitrogenous substances. From the sand which it contains, this material is best adapted for use on clayey soil than on sandy soil. In fact, after the lime and the different fertilizing substances have disappeared, either absorbed by the plants or drawn off by water, the sand will remain in the soil and it acts to increase the mobility of light earth which would be a disadvantage, while it is precisely this lightening up which is desired in heavy soils of a clayey nature, hence the sand is very useful in the latter case. The material is found to have a specially good effect on meadows and wet pasture land which however is not of a marshy nature. It is favorable to the growth of vegetables such as beans, peas and the like on ground of this class. Such fertilizer is also good for plowed ground, and here the material should be incorporated at some depth in the soil and not spread on the surface, especially on damp soil, for this would reduce their effect. Aside from mortar and the like, we should also consider the use of plaster coming from demolitions. Its action as fertilizer is not as yet very clearly defined, but it is considered that this material acts not only as a lime fertilizer, but also has an effect due to the sulfur which it contains. On the other hand, it is probable that it facilitates the absorption of potash by plants and favors nitrification. In any event, its effects are noteworthy upon certain crops, such as pod vegetables (peas, beans), clover, buckwheat and others, and it increases their output considerably. Grapevines show its action to a marked extent, but root vegetables and cereals hardly at all. Plaster therefore should not be neglected, for it can be a source of great benefit to crops in many cases. Plaster material should be well pulverized before use as such plaster will usually contain various impurities such as pieces of stone, brick, mortar, etc. The amount to be used on the soil will of course vary according to the case.

Making New Blood

A VERY remarkable discovery with regard to the blood has just been made by Dr. W. J. Penfold, director of the Australian Commonwealth Serum Institute, London. In the making of diphtheria and other serums considerable quantities of the plasma or fluid portion of horses' blood is used at the institute. The practice has been to allow the blood, after it has been drawn from the horses, to stand for some time to allow the red corpuscles to settle to the bottom. The fluid is then drawn off and used while in the past the red corpuscles have been thrown away. This struck Dr. Penfold as an economic waste so he began experiments in the way of injecting the corpuscles into the horses again. The results have opened up a new chapter in the study of the blood. It appears that the horse can easily and quickly form new fluid if the red corpuscles are put back into the blood. While the normal average amount of blood in a horse is 36 liters it has been found possible to take 48 liters in a week from a horse to which the red corpuscles are returned and that without its vitality being any more, if as much, affected as was the case with ordinary limited bleeding. The practice of returning the corpuscles has been extended to all the horses, between 30 and 40 in number, which are bled at the institute and wider experience is confirming the results of the earlier experiments. The composition of the blood remains practically normal.

It will take some time to realize anything like the full possibilities of so new and startling a discovery but it is bound to have an important bearing on the practice, as well as on the theory, of medicine. For instance there are diseases in which good results might be expected by an injection of the blood of those recovering from the disease but under present conditions the convalescents cannot spare the blood.

Succeeding in Signal Engineering

A Relatively New Field Opened to the Man Who Wishes to Learn While He Earns

By Raymond Francis Yates

SIGNAL Engineering is one of the newer specialized branches of railroad engineering. The problem of safe, reliable automatic signaling grew with our railroad transportation systems and today thousands of men trained in this work are employed in the design, construction and maintenance of signal installations. The signal engineer has come into his own during the past twenty-five years and today he takes his place on the engineering staff of all the important railroads.

The profession of the signal engineer is just as important as that of any other trained man on the staff, since his work is to devise ways and means of protecting life and property in transit over the railroads. This country, with its vast transportation systems, suffers considerable loss of life annually not through faulty signaling but through the human factor. Some of our most terrible railroad accidents have been caused by the engineer going to sleep or dying at the throttle. The signal operator is not infallible and some very serious accidents have occurred through neglect in this part of the present-day system.

When the engineer is asleep there is nothing to prevent the train from passing a signal. On the other hand, if the signal operator makes a serious mistake there is no way for the engineer to know it. These imperfections in the railway signaling systems of today have caused a great many lives to be sacrificed, and one of the most pressing needs of our railroads is a perfect automatic system that will almost, if not quite, eliminate the human factor.

While the railroads were under Federal control the problem of automatic signaling was put in first place among improvements. Experts claimed that the need was for a system similar to that in use on the New York subways. When a subway motorman passes a signal, the brakes are automatically applied and the entire train is stopped within a few feet. Of course, this system as it now stands cannot be applied to steam railroads, because the problem is not exactly of the same nature.

One reading the foregoing lines can easily recognize the future of signal engineering. Although the field is not extremely broad, it is nevertheless promising and holds a good future for those who master its details. There is especial need for men of an inventive turn of mind.

Mr. T. G. Cooke of the School of Applied Engineering of Chicago, Ill., is the Director of the Department of Signaling, and the writer decided to obtain his views on the subject, knowing that his long experience and standing in the field would enable him to give some very valuable and encouraging information to the young men who are surveying the field with the hope of entering this profession. The information imparted in the following lines is given through the courtesy of Mr. Cooke. Nothing but honest opinions are given and there has been no effort on the part of the author or Mr. Cooke to make the field appear more than it really is.

The first matter of importance in reviewing any field is education. The majority of signal engineers today are not college men. This fact certainly ought to encourage the young fellow who has an interest in the field and who cannot see his way clear to attend school. The need for signal engineers has been so pressing during the past few years that most railroads are willing to take on any young men to learn the work as far as they can by experience, and if this is supplemented by study the position of signal engineer is reached within four or five years. This is by no means a "sure-fire" proposition. Much depends upon the man, his ability, courage, honesty, and capacity to do things.

It is the general opinion among railroad officials that a signal engineer does not have to be a college graduate.

Of course, the college man enjoys an advantage over the self-trained fellow, but in this particular field experience counts more than in most professions and oftentimes offsets the advantage of college. A two-year special course in electrical engineering would be a wonderful aid to a man about to enter the signaling field.

One thing that makes it possible for a man to succeed outside of college is the absence of the need for involved mathematics. Mr. Cooke informed the writer that signaling engineering can be taught to a man who has a good, thorough knowledge of arithmetic. For the man who wishes to get out of the "rule-of-thumb" class as far as possible, however, the study of higher mathematics is essential. Work in signal engineering is seldom speculative enough to demand the application of the involved processes of calculus, differential equations, etc. It can be said in general that a knowledge of arithmetic will enable a man to master the details of signal engineering but it will not enable him to lift himself above the crowd who have a similar training.

The subject of signal engineering involves a study of mechanical, electrical and illuminating engineering. That is, the man to be proficient in signal engineering must have an electrical and mechanical education and should have an aptitude for work along these lines. The illuminating work is necessary but most roads at present do not lay so much stress on this as on the other features of the work. Mechanical and electrical work really form the foundation of signal engineering. The work itself in regard to the railroad is divided up into maintenance and construction. Both of these branches are subdivided into such work as testing and repairing, which is both electrical and mechanical.

The design and manufacture of railroad signal equipment is not done by the railroad companies. Several large manufacturers in this country carry on this work. The man who qualifies as a railroad signal engineer with several years of good practical experience will have little trouble in obtaining a position with a manufacturer, providing he desires to enter this phase of the work. The position of designing engineer with a signal manufacturer is one which must be filled by a man who is thoroughly trained. Most of these positions are filled by college men, and the man educated to be either an electrical or mechanical engineer has a splendid opportunity to qualify as a designing engineer after a little experience along this line. A few men who are not college-trained hold positions as designing signal engineers, but they are men of exceptional ability who have struggled to the uppermost heights of their profession.

To qualify for signal engineering a man should be technically inclined and above all should have a liking for railroad work. There is a lure to the railroads that affects many young men; and if those who feel this calling are at all inclined to be mechanical or electrical, then signal engineering is indeed a pleasant field to work in. A signal engineer spends a large part of his time out of doors and this makes for health and vigor. Good eyesight and color sight are absolutely essential for this work.

At a recent meeting of the Railway Signal Association the present shortage of signal engineers was discussed. During the past few years the railroads have found it utterly impossible to obtain properly trained men to carry on their signal installation and maintenance. This shortage exists at the present time and will continue to exist until enough men are trained in this unique but important branch of engineering. The need for men is growing every day; it must grow as the railroads are extended. The future of signal engineering is only limited by the railroads and there is no need for concern regarding the future of the railroads in this country. Many of the railroads of lesser importance do not have automatic signaling systems at present, but it is only a question of time before this system will be accorded universal adoption. Within the next few years many millions of dollars will be spent for signal equipment.

There is positively no opportunity for a man trained in signal engineering to go into business for himself unless he is able to invest his money in an established signal manufacturing company. There is no need for consulting engineers as each railroad employs its own experts. About the only way a man could get into business would be by inventing a new and practical signaling system and interesting capital in it. There is certainly plenty of room for improvement in signaling devices and a man in this field with inventive talent will have little trouble obtaining reward for any improvements he may devise. The railroads are always willing to pay handsomely for anything that will save life and property.

Considering the nature of the work and the amount of training necessary signal engineers are well paid. Men who have reached the upper regions of this profession find little trouble in obtaining salaries as high as $10,000 per year. From this point the salaries range down to $90 per month for beginners in the work. However, this salary is not any lower than a beginner's salary in any other field. Most of the college graduates in electrical engineering receive from $80 to $100 per month when they start in. The traveling signal man receives about $180 per month and to this is added a certain amount for expenses. Division signal engineers receive from $190 to $200 per month. The salary of an assistant supervisor is about $200 per month with all expenses paid. Supervisors generally receive from $215 to $225 per month exclusive of expenses. General inspectors are paid about $250 per month.

Signal engineers, like all other professional men, should have ambitions and ideals if they wish to progress in their field. Every man in this profession should strive to produce a greater safety of life and property and maintain the system under his jurisdiction in perfect order, which will bring about a minimum of suffering and minimum loss of property through wrecks. The casualties of every railroad depend largely upon the signal system. When signals go wrong, trains go wrong and this usually means a disastrous wreck with its consequent loss of life. Every signal man should be proud to feel that it is within his power to reduce the number of wrecks to a minimum in his position of guardian over the movement of trains on the great railroad systems of our country.

IT was our recent good fortune to visit and study the switch and signal installation in the Grand Central Terminal. The occasion was when a French reader of the SCIENTIFIC AMERICAN *was in New York City, as our guest, on a mission of studying manufacturing methods in general and switch and signal mechanisms in particular. Truly, the magnitude of a modern switch and signal installation is wonderful. At the New York Central terminal the trains come and go as though parts of a huge clockwork. In the switch towers the directors, as they are called, follow the movements of trains on an animated miniature of the track layout. Orders are issued by the director to a staff of operators who pull the various levers projecting out from a bank of cabinets. Little green lights indicate the position of any given switch or signal, and whether a track is clear or occupied. An impulse is returned by either switch or signal when its function has been fulfilled, thus conveying positive confirmation to the operator some distance away in the switch tower. Here, indeed, is by no means the least interesting of the many interesting phases of railroading, and Mr. Yates did well to choose this subject for the present instalment of his series dealing with opportunities in many fields.*—THE EDITOR.

Electrified Milk

AN English scientist, Prof. J. Martin-Beattie, of the University of Liverpool, has made important discoveries in connection with the sterilization of raw milk. The common method in use in America and Europe to make milk safe is pasteurization. Pasteurization is absolutely effective, in that it kills all bacteria, but it can be said that it is not a perfect process, for the reason that it alters the taste of the milk. Pasteurized milk is not "raw" milk. The degree of heat and the mode of its application give pasteurized milk usually a flavor which is objectionable to many.

For several years Dr. Beattie and his associates have been experimenting with electricity as a substitute for pasteurization. They have perfected apparatus for running electric current through milk, and have determined the proper quantity to apply. The application of electricity is of very short duration. It does not raise the temperature of the milk to more than 148 degrees Fahrenheit. The milk is not "cooked," not altered in any essential properties through such heating as is incidental to the process.

Solving the Labor Problem—III

How Wages Were More than Adjusted to the Cost of Living, with Increased Output and Freedom from Strikes

By E. W. Hulet, Second Vice-President in Charge of Production, White Motor Co.

THE fact that an industrial concern, employing many thousands of men, has passed through the war and post-war periods without a single strike or any so-called labor trouble whatsoever, is of profound economic significance.

It will not be disputed that a satisfactory adjustment of the relations between the capitalist and labor is the biggest problem confronting the world today. This article is written in the belief that a discussion of the underlying principles and the methods by which the White Motor Company has so successfully solved its own problem under the trying conditions of the past six years, will prove to be of assistance to other establishments that are wrestling with the same problem.

We shall outline the underlying principles upon which our industrial relations system is based, and then pass on to consider the methods by which these principles have been applied.

The Four Elements in Industrial Relationship

In the management of industry, there are four groups to consider: The stockholder who has money invested; the management who plan and direct; the workman who produces; and the public, which consumes. All four are entitled to and must be given their proper consideration.

Business was originally founded for service, and we are endeavoring to give service with proper relations and in proper proportion. Should any one of the above groups not receive its proper attention, the position of the other three would be jeopardized.

We need capital: the producer and the public will suffer if capital is not given its just return. We need the producer (the management and workmen being considered the "producer"): capital and the consumer will suffer if the producer is not properly considered. And likewise, both capital and producer will suffer if the consumer (the public) is not properly and justly dealt with. This is the old-fashioned principle which we are following.

We feel that our production problem is an industrial-relations problem. Maximum production cannot be had without proper industrial relations, and, with this in mind, we have been working for the past six years to build up a proper relation between management and men. Although in no way perfect, we feel that the better relations have helped to bring about the increase in production which is shown in the accompanying chart.

E. W. Hulet, Second Vice-President in charge of Production, White Motor Company, and author of this article

Production Is the First Essential

Production is the first essential and of the most importance to industry. Everything must be working smoothly and properly in the factory if you expect production to run regularly, economically, and at its maximum: and to secure production, there must be high morale and the right mental attitude of men to their jobs and to the management, and of the management to the men.

High morale, the right mental attitude of men toward their jobs, means more to production than high speed. High morale has as its basis confidence in management and confidence in the industry. For the past six years our efforts have been directed toward the building of a solid foundation upon which high morale may thrive. We feel that confidence has been established by placing squarely before the employees, through our committees and the *White-Book*, our factory publication, the problems of the management.

The Men Do Not Want to Manage

The workers do not want to manage. It is no part of their scheme of life. They do not want to share the great risks that are run in assuming the responsibility of management. They, the thinking workmen, will tell you that they have not the length and breadth of vision, the training or general knowledge which are necessary to make good managers. The great majority prefer to remain at their own work, for which they have been trained and fitted.

Contact of Management and Men Through Shop Committees

With a view to bringing about a closer relationship between the management and its employees and to provide a medium through which may be transmitted the thought, feelings, requests and desires from employees to management and from management to employees, we have instituted what is known as "shop committees." Under this arrangement, each department of the works is divided into groups of approximately ten men and a representative is elected by each group. The employees elected by the various groups in one department form the Department Committee. Any employee of the department in which election is held is eligible to act as a committeeman, and the meetings are held biweekly by separate departments on the company's time, and they are so scheduled that only one committee meeting is held at a time. All committees are elected by secret ballot and the committees elect their own chairmen and secretary annually.

The manager and superintendent of the departments represented, with their assistants and general foreman, are privileged to attend the department meetings but are not considered members of the committee. The committee meetings are open forums where all questions of interest, whether pertaining to the factory or not, are freely discussed; questions pertaining to policy, production, expansion and any of the various activities of the factory are debated and graphically illustrated by representatives of the management. Minutes of the meetings and graphic and other charts which have been discussed are posted on the bulletin boards of the department locker rooms for the benefit of the employees.

This very simple form of committee system has been operating successfully in the factory for the past five years. By its means, employees are taught the necessity of production and the proper methods of securing it economically. They are taken fully into the confidence of the management and are given an insight into managerial problems, with every opportunity to follow them up in detail, and, if they so wish, to make suggestions. The "cards are put on the table," and the problems, as they confront the management from time to time, are discussed by a representative of the management at the committee meetings.

Any point deemed of interest may be brought before the committees by members for discussion; and if these are of a nature that would necessitate any great outlay of money or any radical departures from policies and practices, they are referred to the management. If they are considered to be practical and for the good of the industry, they are adopted. When a contrary decision is arrived at, the manager goes before one of the committees, informs them of the fact and discusses the reasons for his judgment.

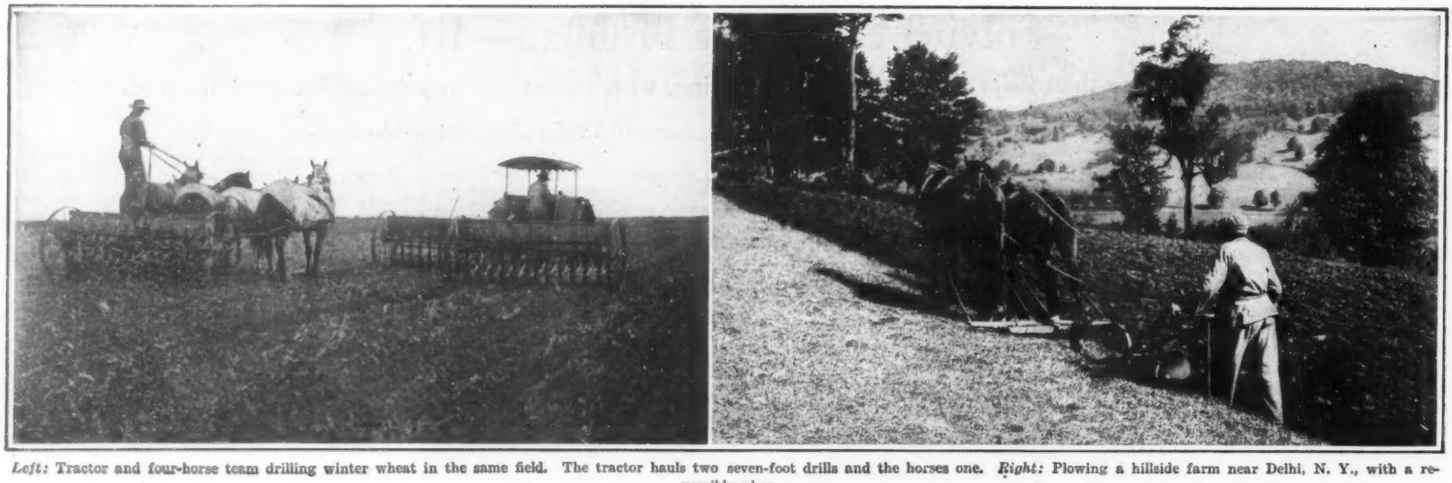
I am in a position to state that at no time has the ability of the manager to judge of such matters been questioned by the committees, and that at no time has the management been called upon to bargain with the men collectively for wages, hours or conditions. The secret of this happy solution of the problem is found in

(*Continued on page 622*)

At the recent meeting of the Society of Industrial Engineers, the White Company was held out as a model in industrial relations. There can be no doubt that here is one large corporation that has been able to convince its workers that it is "on the level" in its dealings with them. Were this not the case, it would not have been possible to make the showing recorded in the table mentioned in the text, which we reproduce herewith:

Year	Factory Value of Product	Average No. Men	Estimated Buying Power of $1	Average Weekly Earnings Based on 51 W'ks' Work	Hours Work	Hours Pay	Total Wages	Trucks Per Man Per Year	Factory Value of Trucks Produced Per Man Per Year
1910	$ 3,836,290	1,072		$14.04	60	60	$ 767,496	2.290	$3,578.63
1911	5,097,523	1,419		12.82	59	60¼	927,696	1.985	3,592.33
1912	6,739,756	1,852		13.53	59	61½	1,278,426	1.785	3,639.17
1913	6,795,196	1,964		13.45	59	61½	1,347,064	1.785	3,459.87
1914	9,023,172	2,202	$1.00	15.03	59	61½	1,688,467	1.924	4,097.72
1915	21,040,078	3,758	.90	16.51	54½	59½	3,163,857	2.460	5,598.72
1916	17,053,311	3,611	.86	17.34	54½	59½	3,186,921	2.082	4,722.60
1917	22,448,927	4,341	.72	20.04	54½	59½	4,637,105	2.040	5,171.33
1918	30,952,748	4,844	.55	27.07	54½	59½	6,688,051	2.720	6,389.91
1919	35,525,427	5,468	.50	31.73	49½	52	8,849,322	2.766	6,496.98

The factory value of the products includes merchandise and supplies, labor, power and fuel, maintenance and repairs, factory salaries and general administrative expense, insurance, taxes of all descriptions, plant extension costs and dividends. The average value per truck on this basis is $2,347; the increase in price since 1914 is approximately ten per cent. The White people attribute the showing to the provision of ample capital and plant and the use of sound methods of manufacture, to management, and to the voluntary giving by the men of an honest day's work.—THE EDITOR.



Left: Tractor and four-horse team drilling winter wheat in the same field. The tractor hauls two seven-foot drills and the horses one. *Right:* Plowing a hillside farm near Delhi, N. Y., with a reversible plow

Two exhibits to deny that the horse is altogether a back number on the modern farm

The Farm Tractor in 1920

An Effort to Reconcile Conflicting Views and State the True Rôle of the Mechanical Horse

By Francis Z. Hazlett

A RECENT report of an interview with a man who by virtue of the office he holds should be well posted on all the uses to which the internal combustion engine is being put, contained the statement: "Tractors and other gas engines have almost entirely replaced other methods on the farm." This man was probably city-born and bred—possibly one who never in his life stayed on a farm overnight. But if he will take the trouble to look over into the fields next time he takes a drive in his auto, or if he will look out of the window for a few minutes while passing through the rural districts next time he takes a trip on the train, he will very likely see quite a lot of "other methods."

Only a few days later another man, who likewise ought to be up to the minute on farming methods and the needs of farmers, told me that in his opinion there are just three reasons why a farmer should own a tractor. He said: "In the first place, if you own a tractor, your neighbors and the people you know in town will consider you a progressive and up-to-date farmer. Second, if you buy a tractor you can keep the boy on the farm one year longer. He will stay with you the year the tractor is new, but will leave the next year. Third, a tractor may enable you to get your plowing done a little more quickly."

Which man was the farthest astray in his remarks? Ask the next dozen people you see who have given any thought to the subject and the chances are you will have a dozen more different opinions on what the tractor has done and can do for the farmers. You will find the man who thinks that inventive genius and industry by providing the tractor have rescued the farmer from endless toil. You will find the man who classes the tractor with the time-honored gold brick and bogus mining stock—just another means of getting his hard-earned money away from the simple tiller of the soil. You will find the man who cannot understand why the cheap and efficient tractor has not lowered the cost of food. Then there is the man who intends to buy a big tract of cheap land and a fleet of tractors and retire on his first year's earnings; the man who says a tractor may be all right for a rich fellow who keeps a farm to spend his money on; the one who thinks that farm tractors won the war; and the one who considers that the tractor is still in the experimental stage, like commercial airplaning or wireless telephony or colored movies.

Gas tractors first came into general use ten or twelve years ago in the northern part of the Great Plains. Great areas of new land were being opened up for settlement and millions of acres of prairie were being put into crops. Horses were scarce and high priced in this territory, little feed was available, and plowing virgin prairie with them was tedious work.

The gas tractors which were then being made were capable of pulling from six to a dozen plows and offered a means of putting this land under cultivation at a rapid rate. The returns from a large acreage of wheat or flax were so great that the farmers were willing to invest a considerable amount of capital in an effort to make a winning, and thousands of them borrowed money with which to buy tractors. However, the machines were crude, the owners often knew little or nothing about keeping them in repair, they were almost invariably overloaded, some of the manufacturers made little effort to supply the users with repairs and as a result many of these tractors which had been bought at great expense were sent to the junk heap. Most of the owners were convinced that the tractor was unprofitable for farm work, and such of them as were not broke or entirely disgusted with farming went back to doing their work with horses.

These first gas tractors resembled the tractors of today just about as much as the first "horseless carriage" resembles the 1920 automobile. Apparently 1905 is the year when a gas tractor designed to furnish power for plowing was first placed on the market. This machine had a double-cylinder engine, used gasoline for fuel and oil for cooling. It was rated at 22 nominal and 40 actual brake horse-power, and was capable of pulling six to eight 12-inch plows, depending on the soil. It was built to look as much as possible like a steam tractor engine and it weighed 9½ tons.

This was just at the time when automobiles and motor trucks were getting their start and manufacturing circles were alive to the possibilities attending the development of a successful farm tractor. By 1909 there were forty or fifty firms and individuals making or attempting to make tractors. Naturally many of these machines were mere makeshifts, for the manufacturers recognized the advantages of getting in on the ground floor of an industry in the making. At best they were heavy, rough affairs, put on the market without a thorough trial by the manufacturers, and when they were tried by farmers they were found wanting in many respects. Buyers of these early tractors found them unprofitable and unreliable, and the whole idea of mechanical power for farm work was given a serious set-back in the minds of farmers.

Manufacturers realized that if the industry was to prosper better machines would have to be built; that they would have to be capable of doing something besides plowing; and that they must be adapted to a

Left: An abandoned tractor on a wheat farm near Salina, Kan. Salvage values appear to mean as little to the tractor farmer as they did to his horse-using predecessor. *Right:* A ten-twenty horse-power tractor running a separator on an Iowa farm

Two tractors of widely divergent model, and the divergent fates that awaited them

wider range of conditions than those which obtained in the bonanza wheat fields of the Great Plains.

It was apparent that these first tractors were too large to be used anywhere except on the big level farms of the prairies, and consequently small machines were built. Today, a large percentage of the tractors being manufactured are designed to pull either 2, 3 or 4 plows. There are probably more two and three-plow tractors in use now than all other sizes combined. From the rough machines of poor design, with crude engines, excessive weight, cast gears and exposed working parts, have been developed compact, well-designed machines with cut and hardened gears, efficient driving mechanisms, radiator cooling systems, enclosed and lubricated working parts, kerosene carburetors and air cleaners. The modern tractor can be handled by one man and is light enough and versatile enough to be used for a great variety of farm work. It is invariably equipped with a belt pulley and is used for all kinds of belt work. There are now at least 100 firms actually engaged in the manufacture of tractors and probably twice that many more who are planning to begin in the near future.

The manufacturers endeavor in every way possible to insure that the purchaser of a tractor will be successful with it. Every year the progressive manufacturer holds tractor schools in all the places where his machines are used in any number. Owners of his machines and in fact anyone who is interested can attend these schools, which may last from two days to two weeks, and learn from experts how to operate and care for the tractor. Most of the State colleges of agriculture give similar short courses in "tractioneering." But even with these great advances, farmers have not "taken to" tractors to the extent which many people profess to believe.

There can be no doubt but that the tractor is a boon to thousands of farmers in these days of scarce, poor and high-priced help, but it is only beginning to make its influence felt on farming in general. When we entered the World War there were probably not more than 40,000 tractors in use in the whole country, and there are more than six million farms—only one tractor for every 150 farms. The number has increased until there were probably 350,000 machines used on this year's crops.

There are some tractors in every State in the Union, but just how many there are in each State and just what kind of farms they are on, no one will know exactly until the returns of the Agricultural Census are completed.

Illinois is generally purported to have more tractors than any other State, but the census may put Iowa, Kansas, South Dakota or Nebraska in the lead. The Kansas State Board of Agriculture has collected data showing the number of tractors in use in the State during each of the past five years. In 1915 there were 2,493 tractors; in 1916, 3,932; in 1917, 4,504; in 1918, 5,415; and in 1919 there were 8,609.

There are eight to ten times as many tractors in the whole country now as there were three years ago, but the ownership of a tractor is still the exception rather than the rule among farmers. And as yet very few farmers agree with the enthusiast who sees a tractor on every farm within the next five years and who imagines that all farm work could be done better, more quickly and more economically with mechanical power than in any other way. On the other hand we would have a hard time finding a real live farmer who concurs exactly with my friend and his "just three reasons." The use of tractors will certainly continue to increase, but the farmer, instead of having been anxiously awaiting a mechanical power plant, must, like any other business man, be convinced that something better than his old method has been produced.

The farmer took to the automobile just as readily as did the city man when he was convinced that it would meet his needs, and today there are more automobiles per capita among the rural population than there are in the cities. Similarly, farmers are buying tractors just as fast as they are being convinced that tractors are needed in their business. It is said that more than half the farms in the country are less than 100 acres in size, and probably 90 per cent of the tractors now in use are on farms larger than this. The principal advantage of a tractor is in saving man labor and in doing work which could not be done by other methods. If the man on the small farm can do most of his work himself and can get it done in good season by using the old methods, it is difficult for him to see how a tractor costing from $1,000 to $2,000 would be a paying investment. Except for the saving in man labor, the cost of doing field work with a tractor is probably no less than that of doing it with horses, and on these small farms it will usually be cheaper to hire belt work, such as thrashing and silo-filling, done than to own a tractor and machinery for doing it. It seems now that unless conditions change radically these small farmers, if they expect to use mechanical power economically, must purchase tractors coöperatively, and make each tractor do the work on two or three farms.

The operators of larger farms where there is plenty of work to make tractors profitable quite generally realize the advantages of the tractor, and the only thing which has kept many of them from adding these machines to their farm equipment is that all their ready money has been needed in other places. With the high price and scarcity of farm help, however, many are being practically compelled to buy tractors in order to get their crops planted.

Some are not yet convinced that tractors are reliable, and there are some who do not think themselves capable of operating a tractor successfully. Still others on account of sentiment or ultra-conservatism do not like mechanical power at all and predict the disappearance of tractors from our farms. It is probable that many such men, even though their farms are well suited to the use of tractors, will never own them. Advocates of this belief point out that the tractor, producing no manure and consuming something of which the farmer can grow no part, must revolutionize the entire economics of farming if it is to succeed. Then they assume that this revolution cannot be effected, and argue that therefore the tractor must fail.

As a general rule the tractor is used to supplement the horse-power already on the farm and most farmers who own tractors still keep a part of their horses. Investigations by the Department of Agriculture and the State Colleges of Agriculture show that farmers who now own tractors have not disposed of more than 20 or 25 per cent of their horses on the average. A survey by the Federal Office of Farm Management of corn-belt farms where tractors are owned showed that on most of the farms horses still do a larger percentage of the work than tractors. If a tractor enables a farmer to get his rush work done in better time, of if it makes him independent of hired help or enables him to enlarge his farm, he usually finds that it is a profitable investment, even though he still keeps horses for work to which the tractor is unadapted.

Another typical case where the tractor can hardly compete with the horse is found on the one-man cotton farm. Here the peak of the season's work is not encountered at plowing time at all, but rather at harvesting time. The tractor cannot be used in picking the cotton, and the farmer can plant and cultivate with a horse as much cotton as he can ever pick. So why should he buy a tractor?

According to the reports of the Bureau of Crop Estimates there were still 26,100,000 head of horses and mules on farms at the beginning of the present year. While there was a decrease of 359,000 head during 1919, this represents only about two head for each tractor which was purchased during the year. It must be remembered, however, that the entire reduction is not due to the increased use of tractors. Automobiles and motor trucks are also factors in horse displacement. At least 50,000 farmers have added motor trucks to their equipment during the last three or four years, and the number who own automobiles has been estimated at more than 2,000,000.

1. Fall plowing of sweet clover after heavy pasturing (Rochelle, Ill.) 2. Seeding winter wheat with an 18-disk, six-foot drill (Warrensburg, Ill.) 3. Harvesting wheat with tractor and binder in Indiana. 4. Tractor pulling eight-foot culti-packer (Macon, Ga.) 5. Corn binder drawn by tractor (Marion, Ind.)

A general indication of the variety of field work of which the tractor is capable

Left: Cleaver splitting the rough diamond preparatory to cutting. This calls for long experience and remarkable skill, since a slip of the tool means a very material loss in the value of the fragments. *Right:* The sawing room, where the dividing of a large stone is carried on with absolute precision, as contrasted with the cleaving method

Two ways in which rough stones are divided up into a number of smaller stones, preparatory to cutting

Our Diamond Industry

How the United States Has Become the Greatest Buyer of Diamonds in the World

By Harry A. Mount

AMERICA is the greatest diamond-consuming nation in the world. Not only do we buy more diamonds than any other people, but we buy the finest diamonds the world's markets afford. It is not surprising, then, that around this traffic has grown a curious miniature industry, whose product is of national importance.

Our diamond industry centers in New York, principally because diamonds and workmen alike have been imported through this port. There is in New York a distinct "diamond district," just above the city's famous financial district. Hundreds of firms and thousands of individual dealers have their offices in this district, and here also are most of the important diamond-cutting plants. Nearly every diamond in this country has passed through the hands of dealers and workmen in this "diamond district."

The diamond district has taken on some of the airs of its neighbor, the financial district, for there are not only brokers, large and small, but a full-fledged curb market where the lesser tradesmen barter among themselves.

Every building in the vicinity of Maiden Lane, John and Nassau Streets has its share of diamond dealers, diamond brokers, diamond cutters, and setters. One skyscraper building is occupied exclusively by diamond interests and diamond jewelry manufacturers.

The curb market, perhaps the most picturesque feature of the diamond district, is at the corner of John and Nassau Streets, where at any time of the year and at any time of the day a group of a hundred or more men can be found standing about, apparently idling away their time, occasionally examining a paper of diamonds under a jeweler's glass. These men are all recognized diamond merchants and deal chiefly among themselves. Many of them have made a section of this curb their office for thirty years or more. While it is impossible to obtain any figures on the amount of business transacted on the curb it is estimated at several millions a year. And this represents just the "tag ends" of the total business done in the diamond district.

Once all the diamonds imported into this country were cut in Holland or Belgium. Fifty years ago a Hollander named Hermann opened a diamond-cutting establishment in New York, but he did only repair work and recutting. There was another small establishment in Boston. From these small beginnings the cutting industry has grown in this country until about a thousand men are now engaged at it and they cut a good portion of the large stones sold here. Because of the high wages paid, however, nothing but stones of considerable value, where the cutting cost is comparatively small, are cut here. But the workmen are the finest in the world, and it is not infrequent that a fine stone already cut in Europe is recut here because of the superior workmanship.

The whole diamond industry is so intertwined with European connections that it is well to recall here, briefly, the system which controls the world's diamond trade.

It is a well-known fact that the mines of South Africa supply nearly all of the diamonds of commerce. India was once the chief source of supply and a few still come from there. A few diamonds are found in Brazil, but there are not sufficient numbers of diamonds found outside of Africa to influence the market. The South African production is controlled by a British syndicate, which thus controls 90 per cent of the world's production, and this syndicate, please take note, carefully manipulates the supply so that it is always a little in arrears of the demand.

It is a rarely accorded privilege to be able to buy direct from the syndicate. Once a buyer is on the syndicate's "list" all he can do is to apply for a "shipment" and await his turn to buy. He is required to fill out an application blank setting forth exactly the character of the goods he wants. He is finally notified that a "sight" of the diamonds will be ready for him on a certain date. It is his privilege, then, to inspect the diamonds and refuse them if he likes. But the privilege of a "sight" is very rarely exercised. If a man rejects a shipment he is penalized by being skipped once or twice when his turn again comes around, or may even be removed from the list. Experienced buyers always take what the syndicate selects for them. Diamonds are apportioned to the different sections of the world according to local demand for color, perfection, size and the like, and since America demands the best qualities the mines produce her buyers usually get the best.

Now most of the buyers on the syndicate's list were formerly in Amsterdam or Antwerp, and in establishing an American cutting industry some difficulty was encountered, not only in finding competent workmen, but in getting buyers "on the list." The process of

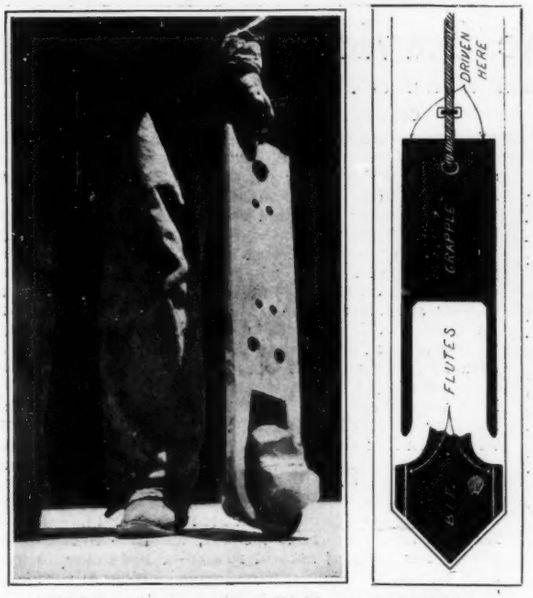
(Continued on page 623)

Left: The setter, shown at the left, adjusts the diamond in the holder for the polishers at the right. Polishing is done by means of close-grained semi-steel disks the working surface of which is impregnated with a mixture of oil and diamond dust. The stones are held against the revolving disk. *Right:* Cutting the rough stones, so as to give them their form

Two stages in the conversion of a rough, sparkless bit of crystal rock into a brilliant diamond

How a Little Ingenuity Retrieved a Broken Drill Set

WHILE drilling a well in granite at a depth of 70 feet, the drill bit broke. The hole was 5¾ inches in diameter and the recovery of the broken bit—a portion measuring about five inches—presented quite a problem. After several attempts a piece of iron was forged with malleable prongs and fastened to a steel rope. The malleable prongs were driven down with such force that they were bent entirely around the broken bit, and raising the prongs and bit to the surface was quite a simple task.—By *R. Franklin Mundorff.*



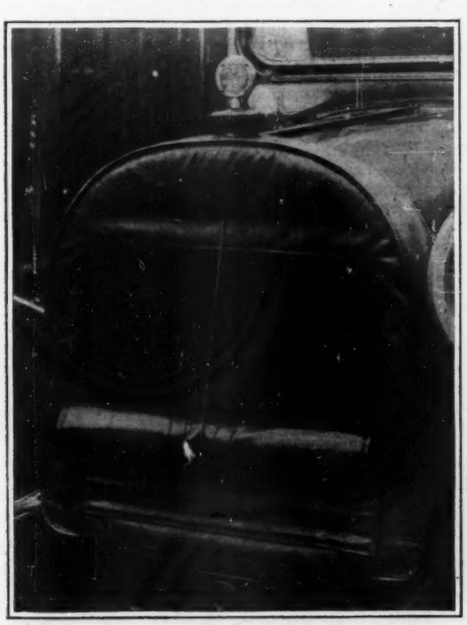
Special iron forging with malleable prongs bent about the broken drill bit, and how the bit was retrieved

Rails Tested by Magnetic Analysis

THE new method of testing steel by magnetic analysis possesses advantages which render it interesting, as a non-destructive means of testing, to supplement tests already in use. Magnetic analysis enables one to detect structural changes due to heating or cooling, or as an indication of mechanical properties; for the mechanical properties of steel are functions of its chemical composition and of its micro-structural and mechanical conditions. The micro-structure and mechanical conditions with regard to internal strains are determined by the heat treatment and the amount and kind of work to which the piece has been subjected. The magnetic properties of steel are also functions of the same variables, and any change produced in one set of properties is accompanied by a corresponding change in the other. The magnetic laboratory of the U. S. Bureau of Standards has developed a method for determining the degree of magnetic uniformity along the length of specimen of substantially uniform cross-section, the method being particularly applicable to steel rails. The test consists in surrounding the rail with a magnetizing solenoid, which is run along the rail. A sensitive electrical instrument, which is connected to a test coil carried with the solenoid, indicates any change in magnetic permeability as the coil is moved along. A method is being developed for testing ball-bearing races on these lines, and experience already gained has furnished sufficient evidence to warrant the conclusion that magnetic methods may be used to advantage in fundamental investigation and for non-destructive testing of steel products. To apply the magnetic test to a forging before machining might save the labor of machining a defective forging.

A Radiator Flap that Unrolls Itself

THE motor car driver can now sit in his car and adjust the radiator cover flap without getting out. This new accessory is so made that it rolls itself when the driver pulls a string. When the control cord is pulled the flap unrolls upwardly. When let out it rolls itself at the bottom of the radiator shutters. The explanation for this is that highly tempered steel springs are made into the flap itself. On the dash of the cord is a cord holder, and a cord guide which guides the cord as it is pulled.—By *K. H. Hamilton.*



This radiator cover flap is controlled from the driver's seat by a simple cord

James Means, Aviation Pioneer

THERE died in Boston on December 3rd James Means, who was largely responsible for the interest of the Wrights in flying. He founded and for several years in the 90's published the *Aeronautical Annual*, in which he made it his business to set forth his ideas with regard to the possibilities of aviation. A regular contributor to his columns was Langley; and it was through their reading of Means' publication that the Wright brothers, according to a speech by Orville in Boston in 1916, were drawn into the design and construction of planes.

Musical Pitchforks in South Africa

A TALE comes out of England which illustrates admirably the sort of unexpected demand which may have to be met in building up a foreign trade. A British manufacturer of edge tools made up his mind to secure a share of the trade in Kaffir picks, and obtained a sample of the native-made pick, which he reproduced so exactly that it seemed to be impossible to detect the difference between it and the native article. His tools, however, did not sell, and a representative was sent out to investigate. He found there was one thing for which the Kaffir used the pick that had not been taken into consideration. The native took it out of its haft and used it as a cattle call, and every Kaffir had found that the British-made pick had not quite the right note. It speaks well for the enterprise of the maker that, having discovered this, he produced a Kaffir pick with the right note and established a trade which, the story goes, he has retained ever since.

A Leadless Insect Spray

THE recent discovery of a lead substitute for the making of insecticides, as disclosed at the convention of the American Chemical Society in St. Louis, is anticipated as being responsible for the saving of millions of dollars of farm products. Credit for devising a method of preparing a commercial grade of calcium arsenate belongs to the scientists of the Insecticide and Fungicide Board, U. S. Department of Agriculture.

The use of calcium arsenate as a substitute for lead arsenate is a notable contribution to the industry of manufacturing insecticides because of the cheapness of lime as compared with lead oxide. Of course, calcium arsenate cannot be sprayed alone on tender foliage but when combined with sulfides its application in fighting crop pests is effective.

The method of making calcium arsenate from lime and arsenic acid is prescribed as follows by the Insecticide and Fungicide Board: Obtain a good quality of lime, slake the product to as smooth a paste as feasible, for such a procedure not only determines the smoothness of the finished product but the willingness with which the lime and acid react. Apply from 3 to 3½ times as much water, by weight, as lime, and have the water warm. After standing for a while mix thoroughly, then adding twice as much hot water as used for slaking, mixing the products again.

Add the acid, at room temperature, to the lime without delay, stirring the ingredients well. Crush in a disintegrator or grind if advisable. In order to produce 100 pounds of a commercial grade of calcium arsenate it will require approximately 50 pounds of high grade lime to be slaked with 18 gallons of water, and then 45 gallons of a solution containing one pound of arsenic pentoxide ($As_2 O_5$) per gallon.

Preliminary experiments led to the belief that calcium arsenate might be manufactured directly from limestone, instead of from lime, thus eliminating the expense of burning. However, subsequent tests showed that the chemical properties were not such as to make a suitable product. And, furthermore, there seemed to be no advantage in attempting to substitute limestone for lime; hence the process as outlined above is the one recommended by the Department of Agriculture.

The calcium arsenate as a substitute for lead arsenate is capable of yielding excellent results on resisting plants in the warfare to conquer crop pests. The Department of Agriculture enumerated the following as some of the virtues of an effective arsenical spray:

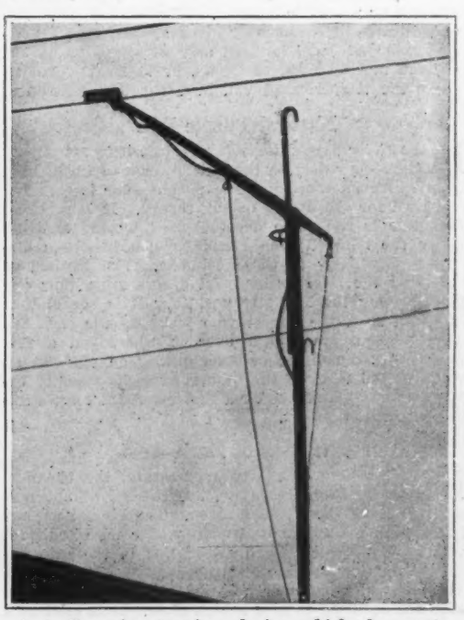
The absence of an excessive quantity of soluble arsenic, which would result in injury to foliage; manufactured in fine particles that it may be evenly distributed over the foliage; light in form when dry, thus affording easy application by dusting; it should suspend well in water, thus permitting of even distribution when administered in the form of a spray; and when sprayed and subsequently dried should cleave to the plants. On this showing it is plain enough that there is no occasion to cling to the established lead-bearing sprays.

Tapping the Trolley Wire Without Stopping the Trolley Cars

THE accompanying illustration depicts the method employed by the United Railroads of San Francisco in taking current from the trolley wire without the necessity of removing the device each time a trolley car passes.

Current from the usual trolley wire is often used to operate machines such as air compressors, concrete mixers, banks of camps, and so on, and it is important that the machines or equipment be operated continuously. With the old method it was necessary to remove the device each time a street car passed; but with the new device the passing of street cars does not interfere with the taking of current for operating the machines. In other words, the current-tapping member does not interfere with the passage of the trolley wheel.

The device is supported on a column that stands at one side of the track a sufficient distance away to enable a car to pass. From this column the arm extends out to the trolley wire, and is held tight against the upper part of the trolley wire by means of a rope. The device can be set up or taken down in a minute.—By *C. W. Geiger.*



A trolley-wire tapping device which does not interfere with the passage of the trolley wheels

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Electrical Production of Alloys

IN a paper before the American Electro Chemical Society, Ralph M. Major discussed the electric production of alloys, pointing out that some of the advantages in melting in an electric furnace are as follows: First, a higher temperature is produced than can be obtained in any other furnace and at the same time this may be controlled. This results in a more rapid melting of the charge and the ability to tap superheated metal, thus allowing time to add deoxidizers and giving the impurities a chance to rise into the slag while the metal cools only enough to bring it to the proper pouring temperature. It is recognized that the requirements upon the refractories are extremely hard. Another advantage is that the atmosphere in which the melting takes place is more nearly non-oxidizing, permitting a greater saving of valuable additive materials such as manganese. Finally, a better quality and more nearly perfect homogeneity of product is possible when using an electric furnace than in any other way.

Case Hardening of Commercial Steels

A CHART has been prepared by H. B. Knowlton for the heat treatment of four types of steel, which should be very useful. The steels covered are carbon, nickel, chrome nickel, and chrome vanadium. The temperatures and directions for quenching, reheating, cooling, etc., are given. The four treatments are divided as follows: Treatment No. 1 gives a steel that is case hard but brittle, with a strong core but not a tough one and it will not stand shock very well. It is the cheapest treatment and should only be used where great toughness is not required. The second treatment produces case hardness somewhat refined. The extreme outside may be brittle and chip off, and while the steel will stand considerable shock without breaking, the core is soft, coarse-grained, and neither strengthened nor toughened.

The third treatment is applicable only where the carbonizing temperature is accurately controlled and it may cause bad distortion on some parts. The steel so treated is not liable to chip. The core is strengthened and toughened and the steel will resist shock well. The fourth treatment outlined is the best, causing less distortion than No. 3 and is recommended where maximum hardness, strength, and toughness are necessary. The steel is not liable to chip, will stand shock well and has a core both strengthened and toughened. An example of this fourth treatment may be given for carbon steel having carbon .15 to .25. Carbonize 1,600° to 1,700°F., cool in boxes, reheat to 1,600°F., quench in oil, reheat to 1,400°F. and quench in water or reheat to 1,440°F. and quench in oil. The temperatures of carbonizing given assume that a first-class compound will be used and all reheating should be done in lead pots, salt pots, or in small furnaces where the temperatures can be accurately controlled.

Natural Purple Dye

IN the *Color Trade Journal* for May, it is noted that a shell-fish exists on the Pacific coast of Costa Rica from which an especially fine purple color is obtained and used for the dyeing of silk thread. It is probable that this is the same dyestuff used by the ancients under the name Tyrian Purple, which has been discussed previously in these columns. The method of obtaining the coloring material differs from that employed along the Mediterranean, for it is stated that in Costa Rica the person who picks up the shell-fish merely blows his breath over it whereupon a few drops of greenish liquor ooze out. The silk thread when passed through this liquor and subsequently exposed to sunlight takes on a fast beautiful color without further treatment.

The Uses of Boric Acid

BORIC acid and sodium tetraborate, the chemical name of ordinary borax, are the most important derivatives of the element boron. The largest use for borax is in making enamel coatings for wire and steel ware. It also finds large application in the glass industry, in the laundry, and the kitchen. It is a convenient water softener and is sometimes found in starches designed to give a high gloss. It is used as a coating for book paper and playing cards, and, as a solvent for shellac, finds extensive application in the hat trade. In tanning, both borax and boric acid are used for cleaning hides and dressing the leather. In the textile industry borax assists in dyeing, and in some parts of the world boric acid is still employed in the preservation of foods. It is permitted in the salting of fish because such foods are soaked in water before cooking and most of the boric acid removed. Being an antiseptic, boric acid is employed for external washes and it finds a place in cosmetics. It is used as a larvacide where it is recommended for the destruction of fly larvæ in manures, for it destroys the larva without affecting the bacteria which increase the fertilizer value of the manure. Finally, borax is a well-known flux used in metal working.

Synthetic Rubber

THE methods employed in Germany for the production of synthetic rubber had been fairly well known for some time previous to the war, when the comparatively low price of natural rubber—a little over 70 cents per pound—made it unprofitable to compete with it. During the war, when price was not a consideration, the industry was expanded, the raw materials being acetone and aluminum. Acetone was secured from acetylene by a process similar to that employed at Shawinigan Falls. However, synthetic rubber could not be vulcanized and therefore was useful only as hard rubber. The natural rubber was mixed with synthetic rubber in order to produce the soft material needed for so many important purposes.

Cooking Oils

FAT used for deep frying must have a high smoking temperature and the smoke when produced must not be irritating to the eyes or nose and must increase slowly as the temperature is raised. While standardized methods for determining these characteristics have not been provided, some of the results published indicate that the hydrogenated vegetable oils as a rule have a higher smoking temperature than animal fats. The smoking temperature is believed to be the temperature of decomposition, and if this is true the animal fats decompose more readily and extensively than do the hydrogenated vegetable oils, becoming rancid earlier and not capable of being used so long. Nearly all the fats and oils used in the kitchen have smoking temperatures near 200°C.

Analysis of Sole Leather

IN *Le Cuir* there is a discussion of the analysis of sole leather with the determination of the water soluble material by the English and French methods. It seems that all physical properties yield data valuable in determining the grade of such leather, including resistance to cutting, compactness of fibers, the color of the cross section, and even the odor, taste, and color. There is apparent need for uniformity in methods, since the two under discussion gave decidedly different results, the English giving the higher values. By this method a sample is first cut and then ground in a suitable mill. Grease is removed from a 25-gram sample by extracting for 6 hours with petroleum ether boiling between 40 and 60 degrees. The solvent is then allowed to evaporate, the leather being spread on a plate in a warm place over night. It is then placed in a Procter extractor, covered with water, and allowed to stand over night, and the next day is heated to 45 degrees at a rate to produce 1 liter of extract in 3 hours. The extract is now filtered through good paper, the first 200 cc. being rejected, and 50 cc. of the clear filtrate evaporated to dryness in a water bath, dried in a vacuum oven, and weighed.

Cottonseed Meal as a Human Food

IN the *Cotton Oil Press* for May, J. E. Halligan discusses the possibility of cottonseed meal as a source of human food. Since 1905 the meal has been used to a limited extent as a human food in Texas, where the meal has been specially prepared by eliminating the hulls and then grinding the meat to a fine powder. When properly prepared, the flour has a bright yellow color, a sweetish taste, and an agreeable odor similar to that of nuts. If the meal has been extracted and all traces of the solvent removed it is somewhat more attractive.

The high protein content, 43 per cent in meal and 50 per cent in cottonseed flour, at once suggests the possibility of using such meal as a meat substitute. This should interest those who find meat somewhat too expensive, since it is a question whether certain classes of workers now eat enough meat at present prices to satisfy their body requirements for protein. According to some of the authorities, 125 grams of protein are required per day for moderate work by the adult man, yet in some families in our cities this is known to fall as low as 80 grams per day, while in other countries statistics show an even smaller consumption.

Another consideration in favor of cottonseed meal and flour is the ease with which it can be kept indefinitely in dry storage in perfect condition without refrigeration. The bakeries have shown that cottonseed flour and meal may be used in nearly all products ordinarily made from other flours, though the products are richer in protein and fat since cottonseed flour contains five times the protein and ten times the fat of wheat flour, and six times as much protein and four times as much fat as cornmeal. Of course, cottonseed meal products may not agree with some individuals, but this is also true of other foods and every man must learn from his own experience the foods which best agree with him. It would seem that under present economic conditions there would be many interested in at least trying this source of the protein, fat, and mineral elements in the diet.

Edible Lactic Acid

UNTIL recently edible lactic acid was not an article of commerce because no way had been found to produce it in competition with inexpensive citric and tartaric acid. Today refined edible lactic acid, 56 per cent by volume and 50 per cent by weight, sells around 35 cents a pound; whereas, citric is $1 and tartaric acid about 80 cents.

Within a year this edible lactic acid has been introduced in large quantities to beverage manufacturers, it having been found that the addition of a small quantity to beers of very low alcohol content greatly improves them by combining with the amides and amino acids which are present. As an acid for most of the soft drinks it is gradually replacing citric and tartaric acids, where 1¾ pounds replace 1 pound of citric crystals and 1½ pounds replace 1 pound of tartaric acid. Such lactic acid also finds use in the baking industry, in candy, production of jellies, and in the canning industry where the use of a small percentage of acid of this type facilitates the preservation of meats and fish.

Our Sugar Supply

SO long as sugar remains difficult to get even at prices that seem unreasonable to us, we can find much of interest in the subject. The sources of supply for the United States during 1919 were as follows:

	Tons
Cuban cane	2,067,051
From the beet crop of the United States	872,253
From Hawaii	514,824
Porto Rico	286,880
Louisiana and Texas	154,034
The Philippines	72,511
St. Croix	8,286

and from maple and sugars from molasses, 34,094 tons. Full duty-paying foreign sugar from miscellaneous sources supplied 57,738 tons, making a grand total of 4,067,671 tons.

This consumption is the highest recorded for any country. Whereas, our great grandfathers consumed about 8 pounds per capita yearly, we reached 85 pounds last year, having gradually increased to that amount from 23 pounds in 1850. It is estimated that in 1920 the consumption for all purposes in the United States will average 90 pounds per capita.

Two statistical items will indicate another cause for the shortage. In 1914 the world's crop was estimated at 19,000,000 tons, of which 9,000,000 tons were derived from sugar beets. In 1919 the total production was 16,000,000 tons, of which only 4,000,000 tons were from beets. The chemist is doing what he can to assist by providing high grade maltose and glucose, but it would seem that we can expect little relief until the beet fields of Europe again become productive after their recovery from the war.

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Special body designed for the effective handling of plate glass

Special Truck Body for Plate Glass Transportation

LARGE sheets of plate glass for modern store fronts are believed to be one of the most fragile of commodities now hauled successfully by motor truck. The adaptation of the motor truck to glass carrying is a problem that has long puzzled body builders as the main difficulty has been in the construction of a satisfactory body to get the floor low enough without underslinging the frame. Manufacturers of plate glass who have tried the underslinging methods state that it has many draw-backs. A Chicago dealer in plate glass has worked out a successful glass carrying truck body that has been mounted on a standard truck chassis and which is shown in the accompanying illustration. It is stated that this body has met every requirement exacted by the great bulk, awkward shape and extreme fragility of plate glass. The height of the floor from the ground is just the normal

(*Continued on page 624*)

Sand Boxes For Trucks

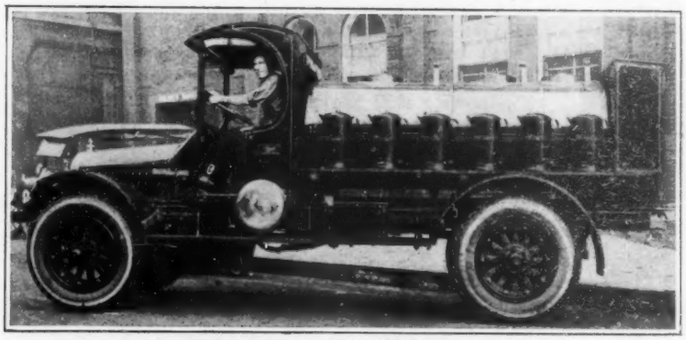
IT is not always possible to operate a truck fitted with traction devices as in some cities regulations have been passed prohibiting the use of any device that may damage the paving of the streets. When the highways are covered with snow and ice the devices can be used advantageously and without breaking the law because they do not come in direct contact with the pavement. There are many conditions, however, where traction is not good and yet the conditions are not severe enough to warrant the use of special traction grips, non-skid chains and similar devices. One of the important adjuncts to trolley cars and railway locomotives is the sandbox, this making it possible to drop sand on the slippery rails and secure traction until the train or car has started. The sand supply is called upon wherever there is a stretch of slippery rails. The owner of a large moving van has fitted his truck with sand boxes and has found them to be of considerable value when the truck is being operated on slippery streets. The discharge of the sand boxes is immediately in front of each rear wheel and is controlled by the driver. When sand is desired a simple control lever opens four discharge nozzles in each sand box and sand is distributed over the ground for a space corresponding to and slightly greater than the width of the tire. This suggestion should be a valuable one to truck operators as the scheme is effective and may be easily applied to any form of truck using solid rubber tires. The sand is not needed as much on pneumatic tire trucks because the modern cord tires made for truck uses are provided with a special tread which gives good traction under practically all road conditions.

Sand box arranged at the rear wheel for better traction on wet and icy pavements

Mobile Concrete Mixing Plant

THE accompanying photographs show a concrete mixing plant mounted on an automobile truck. This plant was developed by the New York Telephone Company for use in the construction of 6½ miles of 12-duct subway between Union and Passaic, New Jersey, and 2¼ miles of 24-duct subway between Jersey City and Newark, New Jersey. The subways constructed were of multiple duct tile with a concrete foundation and concrete top protection. All manholes were built entirely of concrete. The outfit consists of a power batch concrete mixer mounted on a 7-ton motor truck which was also equipped with two

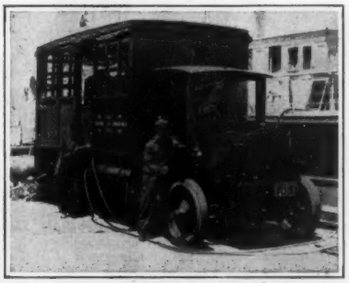
(*Continued on page 624*)



A useful supply truck for fire-department use

Supply Truck for Fire Department

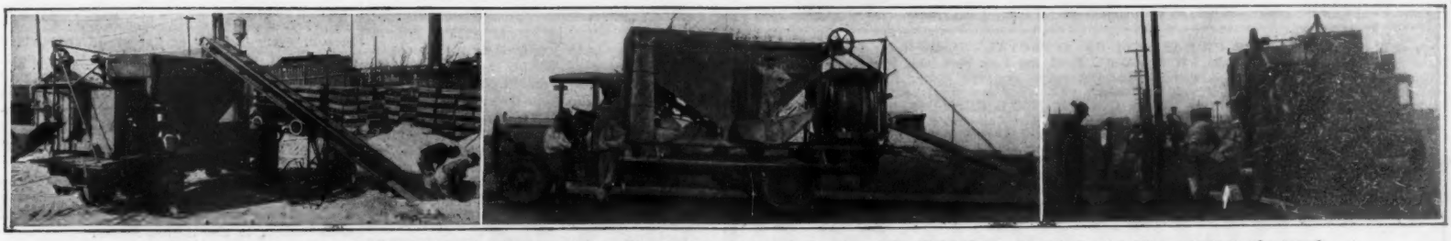
MENTION has been previously made in these columns of the tendency noted in practically all of our large cities to motorize the fire department and not only to use gasoline-engine propelled apparatus but also to replace steam pumping engines with gasoline motor-operated pumps. The horse-drawn supply wagon of the past with its baskets of coal for the steam pumping engine is now replaced by a special truck carrying the liquid fuel and lubricating oil so necessary to internal combustion engines. A vehicle of this type is shown in the accompanying illustration, this emergency oil and gasoline truck being a recent addition to the Chicago Fire Department. A pneumatic tire truck chassis is equipped with a special tank body having running board on which oil tanks are carried. The main tank has a capacity of over 500 gallons of gasoline, while the auxiliary tanks carry 65 gallons of oil. Suitable measures, funnels, tank-filling hose and other tools are carried in a special locker at the rear end of the truck. According to fire department statistics the average consumption of gasoline at a big fire is about 100 gallons, so it will be evident that an effective fuel-supply truck is an adjunct of decided utility. The truck can also be used in making the rounds of the various fire stations to make sure that the tanks of the apparatus are kept filled with lubricating oil and gasoline. The use of pneumatic tires enables the truck to make better speed when its services are required and lessens depreciation in routine work.



The handy welding outfit that goes wherever a truck can go

Mobile Welding Outfit

THE system of welding in which an electric arc is used as a source of heat is of great value in making repairs on the boilers and other metal parts of ships. It is not always feasible to have a current supply of the proper value at the end of a wharf or in a dock where the repair work is carried on. In cases of this kind a mobile welding outfit is operated by a New York concern making a specialty of electric welding. The accompanying illustration shows the manner in which this special truck may be run along side of the boat on which the repairs are to be made. The body of the truck carries a special electrical generating set in which an internal combustion engine drives a dynamo giving current of the proper voltage and amperage to be used in welding. The power plant is self-contained and is independent of the truck engine, will operate on gasoline or kerosene and the arc welding machine will supply power enough for two operators. There is also an air compressor mounted on this truck driven by the truck motor which can supply compressed air for the pneumatic hammers and chisels used in preparing parts to be welded and in finishing off the completed weld. Among the remaining equipment can be mentioned two reels carrying 1,500 feet of welding leads, spare tanks for oil and fuel, air receivers and a complete work bench. The truck is electrically lighted and can be used for night work as well as during the day when rush jobs or emergency work must be performed.



Left: **The wagon loader that simplifies filling the hopper.** ***Center:*** **The complete plant ready for the road.** ***Right:*** **The mixer discharging the contents in the trench**

Three views of the automobile-mounted plant for mixing concrete

Recently Patented Inventions

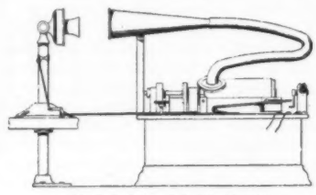
Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farming Implements, Etc

Pertaining to Apparel

GARMENT.—L. T. GOLDBERGER, 395 4th Ave., New York, N. Y. The object of the invention is to provide a garment more especially designed as an outer garment to be worn by children and arranged to permit of readily converting the garment into a bloomer, or romper dress. Another object is to permit of conveniently opening the garment for sanitary purposes without requiring removal of any one of the component parts of the garment.

Electrical Devices

AUTOMATIC BURGLAR ALARM.—F. A. TERRY, Marshfield, Ore. The invention relates to burglar alarms comprising a telephone set and a phonograph disposed near the set, with brake mechanism for holding a switch hook



A SIDE VIEW OF THE DEVICE

in normal position, a motor, an electric circuit for operating the motor, and completing the talking circuit. An object is to provide an alarm which will send in a call for help over a telephone whenever put into operation by the opening of a window or door.

Of General Interest

PEN AND PENCIL HOLDER.—C. B. BIRD, 3617 Ellis Ave., Chicago, Ill. An object of the invention is to provide a simple device which may be secured to the clothing and which will hold pens and pencils securely. A further object is to provide a holder which will be held closely to the body of the person upon whose garment it is attached thereby preventing the pens or pencils from working loose from the holder.

LETTER BOX.—F. P. BOAS, 242 Cedar St., Tamaqua, Pa. Among the objects of the invention is to produce a letter box possessing a number of advantageous features; first the provision of a box having a rust-proof exterior, to provide a box having inner and outer relatively movable parts, the provision of means to limit the relative opening movement, to provide a permutation lock, to provide a form of cover to serve as a holder for newspapers or packages, and to provide a means for locking the box to a vertical support.

VANITY CASE.—S. HASLAM, c/o D. Evans & Co., Attleboro, Mass. The invention has for its object to provide a construction of receptacle having a pair of compartments therein, the partition dividing the compartments being secured in the receptacle and providing a hinged support for the receptacle cover, and also supports a catch which engages the cover to hold the latter in closed position.

Heating and Lighting

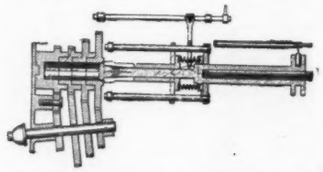
HEATER AND VENTILATOR. — J. A. GREEN, Long Beach Sanitorium, Long Beach, Cal. This invention has for its object to provide mechanism adapted for comfortably heating a room wherein fresh air is taken from the outside, heated and delivered to the room, while the foul air with the products of combustion, is delivered outside the room thus insuring in addition to the heating of the room, a thorough ventilation.

Machines and Mechanical Devices

MECHANICAL MOVEMENT.—F. CLARK, 120 W. 57th St., New York, N. Y. The invention relates more particularly to a mechanism especially adapted for the conversion of reciprocating motion into oscillating motion. The primary object is to provide a device operated by one of the elevators of a typesetting machine to indicate certain conditions in the work being set up by the machine, the device may be readily attached to machines of this type as commonly constructed.

TIRE TREAD PULLER.—J. SCHMIDT, Box 885, Tracy, Cal. An important object of the invention is to provide a tire tread puller in which the pulley action is so exerted and in which the tire is automatically so positioned during the pulling action that the tread will be completely and cleanly removed from the tire carcass.

VARIABLE SPEED GEARING.—K. K. CLARK, 15 Riverside Ave., Jersey City, N. J. An object of the invention is to provide a gear transmission in which the driving and driven gears are always in mesh and to provide means



A LONGITUDINAL SECTION SHOWING THE SHAFT IN IDLE POSITION

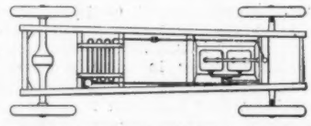
for connecting any of the driving gears with the driving shaft. A further object is to provide means for coupling the drive shaft with any one of the driving gears or position the drive shaft so that it turns idly when not transmitting motion to the gears.

MACHINE FOR COOKING AND DRAINING MATERIAL IN CANS.—A. S. DAVIES, 44 Garfield St., Santa Cruz, Cal. The invention has for its object to provide a machine for cooking and draining material in cans prior to covering and sealing, as for instance fish wherein the cans containing the material are moved continuously during the heating and draining, and are inverted to drain, and finally delivered in upright condition.

TROLLEY.—A. R. WESTERDAHL, Hospital Bay, Cuba. Among the objects of the invention is to provide a link or connecting rod which engages the sheave pins of the trolley and imparts great strength and durability to the structure; a further object is to provide a link which can be placed in position on trolleys as now constructed and which is capable of adjustment to suit the structure on which it is used.

Pertaining to Vehicles

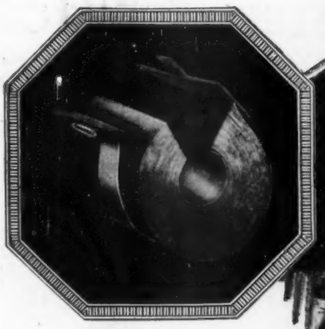
ANTI-FREEZING DEVICE FOR AUTOMOBILES.—F. WENDLING, 9317 87th St., Edmonton, Alberta, Canada. The invention relates to automobile and other motor cars using water-cooled motors and particularly to anti-freezing devices in connection with the radia-



A TOP PLAN VIEW OF CHASSIS SHOWING CONDENSATION TANK AND CONDENSER COIL AT REAR

tors of such motors, and has for its object the prevention of loss by volatilization of the volatile portions of anti-freezing solutions commonly used. The result is accomplished by an appartus capable of ready attachment to an automobile without interference with the normal operation thereof.

VEHICLE REAR END SIGNAL.—SHIBATARO HARA, deceased, Mrs. Lei Hara, Executrix, Muzquiz, Mexico. Among the principal objects of the invention is to provide a signal apparatus which may be employed in daytime as well as nighttime without adjustment or alteration; to audibly draw attention to the operating condition of the signal, and to provide operating mechanism for the signal, which is simple in construction and readily manipulated.



Asbesto-Sponge Felted Insulation

The most efficient commercial insulation known. Built up in ply form and therefore not easily damaged by vibration, handling or rehandling—hence its greater economy because of its longer life in service.

Efficiencies of
JOHNS-MANVILLE ASBESTO-SPONGE FELTED INSULATION ON 5" PIPE

Thickness in Inches	*Temperature Difference Degrees Fahrenheit* 100°	200°	300°	400°	500°
1"	83.8%	86.2%	88%	89.8%	91.2%
2"	88.6	90.3	91.6	92.8	94.1
3"	91.1	92.5	93.5	94.5	95.4

What Insulation Efficiency Means

90 per cent efficiency,—for instance,—means that the insulation of that efficiency saves 90 per cent of the heat that would be lost if the insulation were not applied.

Example:

One hundred feet of uncovered 5" pipe conveying steam at 150 pounds pressure through a room whose temperature is 70° F. *loses* 1,222,000,000 B. t. u. (units of heat) per year. An insulation 90 per cent efficient *saves* 90 per cent of this loss, or 1,099,800,000 B. t. u. (units of heat).

The equivalents of this *loss* and *saving* in pounds of coal are: LOSS—122,200 lbs., or 61.1 tons coal; SAVING by Insulation—109,980 lbs., or 55 tons coal.

The figures on pounds of coal lost due to uninsulated pipe and saved by use of insulation are based on continuous operation, 24 hours per day, 365 days per year and 10,000 B. t. u. available per pound of coal.

Low pulse and high fever cost fuel users millions

How much is lost heat from steam lines costing me?

Not long ago fuel users might ask in vain for the answer. Today everyone can know and save fuel through proper insulation correctly applied. Instruments for determining pressures and temperatures; charts and extended calculations are the tools that Johns-Manville Insulation Service is using to answer this very practical business question.

Whether you burn fuel in the house, the factory or the power plant, read what the science of insulation has accomplished.

* * * * * *

Two symptoms always signal heat loss from a steam-pipe. One is lowered pressure in the pipe, the other is high temperature of the air surrounding the bare or poorly insulated pipe.

Now this falling of the pulse and external fever means that fuel in the form of heat is being lost.

It is Insulation's job to minimize this. And so well is this being done by the Johns-Manville Insulation Service that the materials applied are paying for themselves by the heat they save.

This kind of Heat Conservation has become a science

In past years little was known of the real truths of heat loss. Materials were recommended after inadequate tests; in fact, today if many of the steam pipes covered sometime ago with materials of unknown value were checked up, their covering would be replaced by insulation of known value, and new records for economy set up.

Rising fuel prices make heat losses doubly serious and economy in heat transmission has been realized to be a real factor in cutting heating, power and manufacturing costs.

Changing the physical design of Insulation

An insulation to be of maximum value must have more than the property of preventing heat loss. It must also have physical durability, for a short-life material means early replacement, so that if insulation values are equal, the most durable insulation is the most economical.

If it is desirable to reduce a loss, it is surely advisable to reduce the loss to a minimum. Believing this, Johns-Manville developed physically strong-felted insulations—and with obvious advantages to the fuel user. For these felted insulations are built up in ply form, physically strong and not easily damaged by vibration, handling or rehandling. These improved materials have not only overcome the physical shortcomings of most insulations, but made higher heat efficiencies possible. In fact, on test, one of these insulations has repeatedly been shown to be the most efficient commercial material in existence.

To show the great flexibility of felted insulation, so vital to long life. Nothing to break, crack or powder off as in molded materials.

Insulation for every service

No one material should or will serve all practical needs. Steam service where high pressures are used demands different treatment than cold water or brine service. Johns-Manville, in realization of this, offer materials suitable for use indoors and out; overhead and underground and for every type of system, and not only does this service include the furnishing of the materials but their application as well.

The application of an insulation is vital to its performance in service, hence the necessity of controlling this factor if economical results are to be obtained.

Johns-Manville Insulations

Asbesto-Sponge Felted, 85% Magnesia, Asbestocel, Zero, Anti-Sweat and Ammonia Insulation, Underground Conduit Insulation and Insulating Cements.

JOHNS-MANVILLE
INCORPORATED
Madison Ave. at 41st St., New York City
10 Factories—Branches in 64 Large Cities
For Canada:
CANADIAN JOHNS-MANVILLE CO., Ltd.
Toronto

JOHNS MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

Radio Prize Winner for 1919

THE Lieut.-Col. Liebermann Memorial Prize, consisting of the interest for 1919 on $10,000 and awarded for the best work of the year in progressive discovery tending toward the advancement of radio, has been awarded to Roy A. Weagant, consulting engineer of the Radio Corporation of America, for his discovery—elimination of static interference.

This prize, founded a year ago by a friend of Lieut.-Col. Liebermann, who was killed in action leading his troops in France on August 8, 1918, was awarded for the first time to Leon F. Fuller, chief engineer of the Federal Telegraph Company a year ago.

Mr. Weagant, honored this year, is a native of Morrisburg, Ontario, Canada. He was educated at Stanstead College and McGill University. He studied physics under Sir Ernest Brotherford and first became interested in wireless through witnessing some of his experiments in Hertzian waves. He took up commercial wireless work in 1908 and in 1912 entered the employ of the Marconi Wireless Telegraph Company of America. He soon rose to the position of chief engineer and when the Radio Corporation of America absorbed the Marconi Company he was retained as consulting engineer.

Mr. Weagant is a fellow of the Institute of Radio Engineers and a former member of its board of directors and standardization committee.

Power and the City

(*Continued from page 608*)

plants at San Pedro (the harbor district of Los Angeles) were of course founded to meet the stress of war, but their projectors were governed in their choice of a location chiefly by the cheap power supply.

Another great industry, made profitable by cheap power, is the canning of fish, particularly sardines, which abound in the adjacent ocean. Still another is the making of automobile tires. This was, of course, based on the successful growing in Arizona and southern California of the long-staple Egyptian cotton that is so essential to the making of good tires. The company that started Egyptian cotton growing in Arizona in 1918 speedily realized that the abundant water and cheap power of the aqueduct would not only enable it to make tires at Los Angeles for all Pacific coast points but would also enable it to ship them East by water and deliver them to its trade more cheaply than was possible to deliver from its big factory at Akron. Its cotton spinning factory, which alone will operate 33,000 spindles, for which the company expects to import 1,200 skilled women operatives from New England, was scheduled to open in June and the rest of the great tire factory, with 6,300 more operatives, in September. Another tire factory is to break ground immediately.

An industry moré recently initiated in southern California is that of making vegetable oils. A company which has been operating a huge plant at Portland, Ore., recently broke ground at San Pedro for a new factory, to which it purposes to transfer its business. Cheap power was the controlling factor.

When the aqueduct was being built an $800,000 plant was built to supply the enormous quantities of cement needed in the work. Since the work was finished this plant has lain idle, its hugeness making it too costly to be successfully operated under competitive conditions. Recently it has been leased by the city to Portland people who are now transforming it into what they say will be the largest commercial potash factory in the world. While the ownership of great deposits of feldspathic rocks in the country southwest of Los Angeles was an inducement to the company to come there, yet it was only the cheap electric power that made it possible to operate at all.

Each of these big industries has its own story—and a fascinating one at that. But the one factor that stands out in all of them is that they located where they did because of the cheapness and abundance of the electrical power of the aqueduct.

Other industries, impracticable without electric power, have been begun in a small way and will probably be rapidly expanded.

Among these is iron making. California, though not popularly known as an iron-producing State, nevertheless has an abundance of low-grade iron ores, which have never been mined because no coking coal for their melting was economically available. The electric furnace, however, does not need coke and is expected soon to turn out enough pig iron to supply the coast's needs for use in the fabrication of products for the local market.

A much more important class of ores, abundant in southern California but up to now capable of being handled economically only at Niagara Falls, is those from which chromium, tungsten, vanadium, molybdenum, manganese and other rare metals can be extracted. All such products, which though not great in tonnage nor volume are of enormous importance in the steel industry, can now be extracted by the electric power of the aqueduct and the prohibitive railroad freights to Niagara Falls eliminated. Again, the copper ores of Arizona and Utah, now shipped to Perth Amboy, N. J., for electrolytic refining, can be refined with a great saving in railroad freights by means of the cheap power of the aqueduct current. Truly, electrical water power is the present-day magician at whose behest factories and cities rise.

The extension of the light and power systems of the aqueduct throughout Los Angeles has not been carried on without strong opposition from at least one of the private electrical supply plants that supplied the city before the aqueduct was built. When the question of an aqueduct was first mooted, the companies in possession of the field naturally opposed the whole project. When overwhelmingly overruled by the people at a special election, they utilized the five years that it took to build the aqueduct in entrenching themselves in the city. Nevertheless, when, in January, 1917, the city began to distribute and sell electrical power its ability to conquer the field was so evident that one of the two companies immediately proposed serious negotiations for the sale to the city of all its transmission lines and business within the city limits. The company's stations were outside the city and much of its service was to extra city customers scattered over an extensive area, and this part of its business it of course wished to retain. Its proposal was so plainly in the public interest both in and outside the city that the municipality at once agreed to it in principle and stopped building distribution lines in the part of the city occupied by this company, pending agreement on details, thus avoiding the economic waste of building parallel lines.

The second lighting company, which occupied a large section of the city, took a different view of the situation and refused to consider negotiating the sale of its business to the city under any conditions. So the city "invaded" its territory by building distribution lines into it. Apparently, the contest was brief and decisive, 75 per cent of the company's customers changing over to the city lines as soon as these were available. Actually, however, the company's lines covered a large part of the urban portion of the city, and the part that had been invaded was comparatively small. It was of course apparent that the city could conquer the company's territory if it cared to continue the invasion on a large scale, but this would involve a heavy economic

The Hack Saw Chart

Which saw will insure the most economical cutting of any particular material? One has only to consider the multiplicity of factors as represented by the material, the saw and its operation, to realize the difficulties encountered in arriving at the correct solution of this problem.

Necessity Universally Recognized

Practically every saw manufacturer has made some attempt to answer the question. A number have gone no further than to suggest the obvious—that is, that the saw used for cutting brass or sheet metal should have more teeth per inch than that used when cutting steel or round stock. Some, however, go further than this though not necessarily to the extent of conducting careful tests and the compilation of records over a series of years as one or two have done, but yet far enough to recommend with some degree of definiteness, the employment of blades of certain physical characteristics, to cut certain classes and shapes of metal.

The Practical Solution

One manufacturer—The L. S. Starrett Company—as the result of experiments and tests, has divided materials and shapes into nine such classes, the distinction being based on observation of the influences exerted by the hardness, ductility, crystalline structure and chemical composition of the various metals, and the diameter and shape of the material to be cut. For these different classes of materials, different blades have been designed and manufactured, and the classifications, with the blade recommended for each, have been embodied in the HACK SAW CHART.

In a more elaborate and technical way this Chart might have been made up so as to show the composition and temper of each blade, but for the fact that saw numbers on the chart supply all necessary information where saws of this make are employed.—From *Hack Saws and Their Use*, published by The L. S. Starrett Co., Athol, Mass., for free distribution. A copy of the Starrett chart will be sent free upon request.

loss by the necessity of duplicating the company's lines and would at the best unnecessarily use up money which might better be used in supplying parts of the city that had no electrical service at all.

So the city simply held the part of the area that it had conquered, and for the time being spent its available money elsewhere, notably in building heavy transmission lines to the harbor district, where the municipal docks, cotton compresses, fish canneries, shipbuilding, and other plants wanted the power to supply their growing needs. It also built into an industrial district on the east side where many factories, large and small, were using oil for fuel; this was done at the request of the United States Government, which desired to conserve oil for war and other purposes by substituting hydro-electric power. This resulted in a marked rehabilitation of the district.

The electrical energy at first in actual use was derived from what is known as the San Francisquito power plant No. 1, located on the line of the aqueduct 47 miles northeast of the city, which develops 37,500 horse-power, and from a minor plant which develops 3,000 horse-power and is commonly used to help carry the peak load at the rush hours of the day. Another plant, known as San Francisquito No. 2, located in the same canyon seven miles nearer town, was finished in June and has added two units of 19,000 horse-power each to the existing service. A third unit of 19,000 horse-power unit will be added at this plant later. Two other plants, San Fernando and Franklin Canyon, located much nearer the city, will contribute 14,000 horse-power by Christmas. The same water will successively furnish the power to each and every one of these plants.

All told more than half the total developed and potential power of the aqueduct is practically at the city gates; the rest is more distant and will require longer though by no means unusually long transmission lines.

Solving the Labor Problem—III

(*Continued from page 611*)

the fact that the management and the men, always having played fair, have come to have confidence in each other.

Relationship of Wages to the Cost of Living

In formulating our system of industrial relations, naturally the question of wages occupied a leading position. We devoted a great deal of time and study to this subject, going back into history for suggestions and guidance. We found that a comparative study of the trend of the cost of living for many centuries and in many countries, showing the natural effect upon it of various wars, furnished us with a basis for computing the probable trend in America during the period of the late war and subsequent production.

We then drew up plans for a steadily increasing wage scale, designed by automatic periodical advances to keep pace with the increasing cost of living and thereby make it possible for the workmen to maintain a normal standard of living. We are glad to be able to state that up to the present time, this forecast has been fully justified, the average wage having more than doubled, while the purchasing power of the dollar has shrunk by one-half.

In connection with our study of this subject, we found no *satisfactory* system of bonuses, profit sharing, premiums, piece rates or other participation in earnings of any kind, although some of these plans have been adopted and are apparently successful in many other industries.

Our policy is to maintain what we consider to be a just rate of interest on capital stock and then, after making provision for the necessary overhead charges, we share our profits with our employees every two weeks in their pay envelopes.

How So-called "Welfare Work" Is Handled

In working out a system of so-called "welfare-work" we have realized that to be effective it must not carry with it to the minds of the men any idea of charity or paternalism. This conviction we found to be very strong among the men themselves. They wished that everything that was done in the way of benefit societies, recreational clubs and restaurants should be regarded as services to the employees for which they pay. They believe that the cost of these things is a part of the cost of production. Consequently, the maintenance of these departments stands on the same basis as the maintenance of purchasing, cost, or payroll departments, and the men understand that through their production they are paying for such service. The costs are charted, to show cost of each department on a "per day, per man" basis. These charts are placed before the men with the understanding that, by a two-thirds vote in the factory, any of the service activities, other than those necessary to comply with State requirements, can be discontinued.

There is not space within the limits of this article to describe these welfare activities in detail. There is the factory kitchen and restaurant, which supplies food at a figure slightly below cost; a library to which employees have easy access at all times. The latter is operated as a branch of the main public library, making it possible for a man to order any book from that institution on the card issued by the company's branch. Recreation in the form of athletics forms a large part of these activities and includes a baseball team, basket ball, bowling, football and other clubs.

A very important organization, also managed entirely by the employees, is the Benefit Society, under which, in case of sickness, a member is paid $12 a week for twenty weeks and $10 a week for the next twenty weeks. The death benefit is $500, half of which is donated by the company and the other half paid by the society. Another activity that is exceedingly popular and has proved to be very helpful is the factory publication known as the *White Book*, which is published monthly. It is mailed free of charge and reaches some 20,000 people. Contributions are received from all departments, both in the factory and office, and it serves as a medium of mutual interest and education for management and employees alike. The more serious part is occupied by articles of a technical or educational nature and by editorials which place before the employees all of the company's policies, with full discussions thereof.

Americanization of Employees

For the benefit of non-citizens employed in the factory—about 20 per cent on January 1, 1919—a course of instruction is given during company time by an educator particularly fitted for this work, the principal object being to enable these employees to get their second papers. On January 1, 1920, after a year of such instruction and assistance, there were but 68 out of 5,826 employees who had not as yet secured their first papers.

Conclusion

We desire that our people be reasonably contented. We want them to realize that the position of our establishment in industry, and its continued growth offer them their opportunity for development, and practically secures for them their economic status in society. We want them to understand that it is only by the continuous growth of the industry that we are all raised out of our present conditions, and then only through work directed by intelligent management. We give them to understand that we can attain our ideals only by all of us diligently working together for one common end. We are educating our men in the fundamentals of economics, in the bene-

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fits of honest coöperative efforts and in the value of service, not only in industry, but in society and in the home. We believe that this kind of education will bring about a harmonious understanding, on the part of the men, of the policies of the management and the principles upon which they are founded. To show the importance attached to our education, and Industrial Relations, this department is placed at the top of our organization chart, believing that the other functions, namely, engineering, production and manufacturing, no matter how perfect within themselves, can be even more effective when preceded by the proper education.

Our Diamond Industry

(Continued from page 614)

getting "on the list" is a long and tedious one, sometimes requiring fifteen or twenty years of persistent effort on the part of an individual.

And so not only were the diamonds and the workmen imported from Europe, but the buyers of the rough stones had to be imported, too. It is because of this fact that many of the important New York diamond merchants even today are descendants of Dutch families, and can trace a lineage of diamond merchants through a century or more.

It is said that fully 80 per cent of the diamond cutters in New York are Hollanders or the sons of Hollanders, and practically all of them are from families in which every male member is a diamond cutter. These cutters are all members of an international union which controls very closely the apprenticeships to the trade. Until very recently it was practically impossible to learn the trade unless the lucky applicant had some relative already in the union. The union fixes wages, but the wage any individual receives depends upon his skill and speed as a workman. A year ago, when the demand here for diamonds was phenomenal, diamond cutters in New York made from $100 to $150 a week.

Excepting that steam and then electricity have been applied to the diamond cutters' tools to replace foot-power, there has been slight progress in the art since the days of antiquity. The only really important invention to aid the diamond cutter during many centuries of steady activity has been the diamond saw, which has been in use for a number of years. When the rough diamond arrives at the factory each stone is closely examined to determine the weight, flaws, and the direction of the planes of cleavage, which can only be determined by an expert. If it is decided that the stone should be divided into two or more pieces, the cleaver cements the diamond to a wooden stick and with another diamond cuts a narrow groove at the exact spot selected. A dull steel knife is inserted in this groove and a smart blow struck upon it. If this has been skilfully done the diamond divides at once and both surfaces are as smooth as if they had been polished. The process requires the greatest skill and care on the part of the cleaver for any error would cause serious loss.

The later method of sawing accomplishes the same result but with less chance of error. Half of the stone is imbedded in a small metal receptacle filled with melted soft metal and the edge of the circular bronze saw is set against it at the point selected. The saw gradually cuts its way through. It may require from three to four days to cut through a large diamond.

After the stone has been cleaved and sawed into the most economical sizes for cutting, the pieces are fastened with a strong adhesive to the demountable spindle of a small lathe. A number of diamonds are similarly mounted. A diamond is screwed on the end of a handle and is used as a tool for cutting the diamond in the lathe, being held against it by the workman. The stone used as a

tool is worn away at the same time, and it is manipulated so that both stones are gradually brought to the proper shape. When the stone in the lathe has been finished, the one used as a tool takes its place and another is used as a tool. Thus the diamond is "turned" into a lusterless cone of the usual diamond shape. Then it goes to the polisher.

The polishing takes place on a horizontal disk which revolves at an extremely high rate of speed. The disk is of a close-grained semi-steel which founders in the country have so far been unable to produce. The working surface is impregnated with a mixture of oil and diamond dust and when the stone is held against the revolving disk a flat face or "facet" is gradually ground on it. To secure the greatest brilliancy the stone must be cut according to an exact formula, having a definite number of facets and with precise angles between them. The stone is mounted either in a mechanical holder or at the point of a pyramid of lead and tin composition, while the holder is secured to a short copper rod. By bending this copper rod one way or the other the workman varies the angle of the cut. He is provided with a crude gage for determining the proper angle of the facets; but for the final accuracy he must depend mainly on his eye. Since the brilliancy and value of the stone depend on the accuracy of his eye, it can easily be seen why the polishing of these precious gems is entrusted only to the most expert workmen.

However all that may be, Yankee ingenuity has invaded even the sanctified realm of the diamond polisher. A machine has been invented for regulating automatically the angle of the cut, size of the facet, and number of facets. Still, a majority of gem experts continue to believe the process is not entirely successful, and it seems likely the expert diamond cutter is in no immediate danger of extinction. Each stone, it is argued, ought to be considered as an individual, for there are no two alike. Each should receive a little different treatment to bring out its full value and this can only be done by the expert workman. For this reason the best stones, no doubt, will always be cut by hand.

Recent news dispatches from Berlin bring the statement that at last German scientists have succeeded in making synthetic diamonds which cannot be detected from genuine stones by any of the accepted tests. New York diamond merchants generally disbelieve the statement.

"I do not believe," said a gem expert to the writer, "that it ever will be possible to duplicate a diamond so that an expert cannot detect it. The successful manufacture of synthetic rubies and sapphires has not affected the market for these genuine stones. The genuine stones are selling for a higher price today than ever before, and that in spite of the fact that the synthetic stone is being made better and cheaper every day. Even if synthetic diamonds are achieved—and I doubt if they ever are—I do not believe the market for real diamonds will be in the least affected."

Along with the growth of a diamond industry in this country, and partly because of it, the average American has become "diamond wise." He knows a good stone from a bad one; he can detect a flaw; and he knows a good color.

"Fifty years ago," says the gem expert, "it was only necessary for a jeweler to guarantee that a stone was a genuine diamond to satisfy the customer. Today the customer knows too much about diamonds to be satisfied with any such superficial guarantee. This creates a demand for fine gems which, in turn, is the reason for the existence of an American diamond industry.

"Fifty years ago it was only the leading jeweler of any city who carried diamonds in stock. Today you can see windows full of them on display, even at the cheaper class of stores. The diamond has come to be something of a factor in American life, and I think it has come to stay."

Special Truck Body for Plate Glass Transportation

(*Continued from page 617*)

height of a man's hand when the arm is extended for effective lifting. Consequently, loading and unloading the truck is much easier than would be the case if the glass sheets were carried higher. The closer to the ground the glass comes, within reasonable limits, the less the chances of trouble due to dropping it. One of the important advantages incorporated in the construction of the body is the fact that the sheets of plate glass are loaded into it in a vertical position instead of being placed horizontally. The advantage of this is that sheets of plate glass of large size can be carried on a body of ordinary width that could not be handled very well if a wide truck body was required, on account of difficulties of maneuvering in traffic. The rack sides of the truck body are provided with special clamping members that hold the plate glass firmly against the packing strips. These clamping members consist of slotted guides having felt pads at the end, which are held in place against the glass by means of substantial wing nuts. The method of using the clamps is clearly shown in the rear view of the truck. The wheel base of the truck is 14 feet and the frame length 16 feet. In order to supplement the easy riding the truck is fitted with special cushion wheels which supply a resiliency greater than that which would be obtained by the ordinary solid tire. It is stated that since the truck has been in service, no matter what size sheet of glass has been carried, not a single piece has been broken in transit.

Mobile Concrete Mixing Plant

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gravity hoppers, one for sand and the other for stone, together with a water tank.

The materials for concrete were assembled at some convenient central location on the job and the stone and sand loaded into the hoppers by a power loader, as shown in one of the photgraphs. Bags of cement were also put on board and at full load the outfit carried material sufficient for five cubic yards of concrete. The power mixer was fed by a laborer on the truck shoveling sand and stone from openings at the bottom of the gravity hoppers and the concrete was poured directly into the trench or manhole excavations by means of a spout. It was found that with a little practice the truck chauffeur could regulate the forward movement of the truck to give the required thickness of concrete in the trench, so that very little hand spreading was necessary. This equipment was developed to meet the conditions existing along the route over which the subway was constructed between Union and Passaic, N. J., where traffic was very heavy, the highway comparatively narrow and bounded on each side by swamps.

To deliver the concrete material along the trench and mix it with a non-automobile mixer would have required platforms in the swamps for the mixer and material about 500 feet apart at a very high cost. The saving by the use of the automobile concrete mixing plant was, therefore, very great. On the Jersey City-Newark run, while it would have been possible to mix concrete in the usual manner at various stations along the trench, the use of the automobile mixer plant was found to be about 25 per cent cheaper than the use of fixed concrete mixing stations and the dumping of concrete into the trench and manhole excavations from wheelbarrows.